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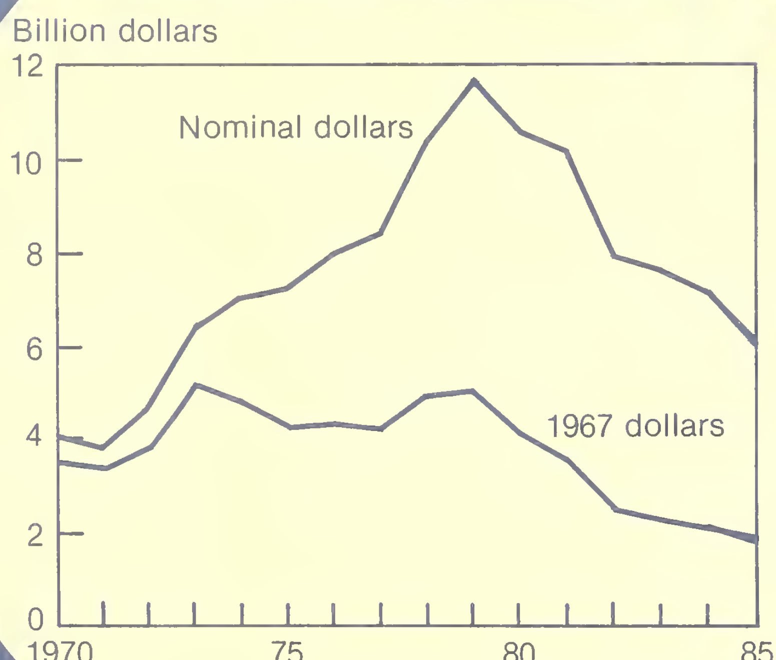

Farmers purchase less farm machinery for sixth straight year. . .

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SUMMARY

DEMAND FOR FARM MACHINERY DOWN SHARPLY

U.S. farmers are expected to buy $6.4 to $6.6 billion of new and used farm machinery this year, compared with $7.3 billion in 1984. The estimate is down significantly from the February projection, primarily because of the continued weak farm economy. The domestic farm machinery outlook for 1986 calls for continued declines in farm machinery expenditures.

Purchases of over-40 horsepower two-wheel drive tractors in 1985 are forecast to drop more than 4 percent to 60,300 units, while purchases of all four-wheel drive tractors are expected to decline nearly 30 percent to about 2,900 units. Farmers also are projected to buy around one-fourth fewer self-propelled combines and corn heads than last year, and forage harvester purchases are anticipated to fall around one-fifth. Demand for most haying equipment, however, may remain about the same as last year.

The U.S. farm machinery market currently has a 10- to 18-month supply of new wheel tractors and harvesting equipment. Manufacturers have significantly reduced production, but not enough to keep pace with declining demand. Nearly all major domestic manufacturers plan further production cuts during second-half 1985.

The U.S. farm machinery trade balance was $6.5 million in first-quarter 1985, down dramatically from $90 million in first-quarter 1984 and $506 million during calendar 1984. Export markets are weakening while imports are rising steadily. The domestic farm machinery industry is having an increasing share of its total output produced overseas, due to lower labor and material costs and the high value of the U.S. dollar.

The farm energy outlook is characterized by plentiful supplies and moderate prices. Farm prices of gasoline, diesel, and LP gas during 1985 are expected to remain stable or decline slightly from a year earlier, while natural gas and electricity prices probably will increase, but by less than the rate of inflation. Energy expenditures dropped from $9.6 billion in 1983 to $9.2 billion in 1984, and are likely to decline further this year largely due to farmers' continued efforts to conserve energy.

Congress has passed P.L. 98-616 regulating underground tanks used to store petroleum and other hazardous substances. Federal rules that will take effect over the next few years may have financial and legal implications for farmers. The Environmental Protection Agency (EPA) is surveying farm and nonfarm businesses to determine the number of leaking underground tanks, and plans to issue standards and guidelines for new underground tanks by February 1987.

During 1974-83, land irrigated with on-farm pumped water increased 9.5 million acres to 44.6 million. Meantime, pumping expenditures rose from $551 million to $2.5 billion, due to the rise in irrigated acres and sharply higher energy prices. Groundwater accounted for nearly 80 percent of the water applied to the newly irrigated acreage. Energy prices, commodity prices, and the availability and adoption of new irrigation technology will dictate future trends in groundwater irrigation.

Total farm pesticide use on major field crops in 1985 is projected at 505 million pounds, active ingredient, with herbicides acounting for 85 percent. In May, herbicide prices were down 4.4 percent, and insecticide prices were off slightly from a year earlier. This fiscal year, EPA initiated reviews of the herbicides alachlor and cyanazine and the fungicides captafol and triphenyltin hydroxide (TPTH). EPA proposes to cancel all nonfood uses of the fungicide captan, as well as most nonwood uses of pentachlorophenol. Also, EPA has proposed criteria and procedures for a new pesticide review process called the Special Review, and is initiating an extensive national survey of pesticides in groundwater.

Fertilizer use in 1984/85 is projected to be near the 21.9 million tons of plant nutrients used a year earlier. In May, U.S. fertilizer prices fell 8 percent from a year earlier due to unchanged domestic consumption and plentiful supplies. Meanwhile, increased world fertilizer demand boosted U.S. nitrogen exports more than 70 percent and phosphate and potash exports more than 40 percent.

FARM MACHINERY

Demand

Financial Conditions

Demand for farm machinery and the well-being of the farm machinery industry are heavily dependent on the state of the agricultural economy. Continued weakening of the U.S. farm economy in 1985 has substantially reduced demand for new farm machinery and has severely impacted the domestic farm machinery industry. Although interest rates have fallen and the value of the U.S. dollar is down this year, export demand is very weak for U.S. agricultural commodities. Lower returns to agricultural producers have in part caused cropland values to plummet, causing financial instability. U.S. farmers currently are projected to spend between $6.4 and $6.6 billion for new and used farm machinery in 1985, down 9 to 12 percent from a 12-year nominal low of $7.28 billion in 1984 (table 1).

Lower inflationary expectations, sluggish economic growth, and a record-high U.S. dollar in early 1985 recently encouraged the Federal Reserve Board (Fed) to adopt a less restrictive monetary policy, which has led to above-target growth in the domestic money supply. This, combined with an expectation that Congress will pass a deficit-reducing Federal budget package this year, has caused interest rates to fall, resulting in the only significant positive financial aspect for the U.S. farm sector this year. The annual average real prime interest rate (adjusted for inflation using the 1972 GNP implicit price deflator) is forecast to be about 6.3 percent in 1985 compared to 8.4 a year earlier. In turn, the farm sector can expect the real national average Production Credit Association rate to fall to 7.8 percent. It has also seen the Ninth (Minneapolis) Federal Reserve District agricultural banks' short-term real rate for non-real estate operating loans decline to about 9.5 percent in January-June. It appears that the Fed will maintain an expansionary monetary policy during the remainder of 1985 to spur economic growth.

Aside from declining interest rates, which have lowered farmers' capital and annual operating costs, total real farm production expenses are forecast to fall about 1 percent to $138 billion this year from $139.2 billion in 1984. Production expenses are declining primarily because prices for most major purchased farm inputs are stable or declining slightly. The July 1985 index of prices paid by farmers (1977=100) stood at 164, slightly below levels recorded during all of 1984. Lower production expenses, however, are not expected to increase overall returns to agriculture, as commodity prices are projected to fall even further in 1985. The index of prices received by farmers has steadily declined from 145 in May 1984 to 127 in July of this year. As a consequence, the ratio of prices received to prices paid fell from 88 in 1984 to 77 in July.

The major financial problem confronting many farmers is the sustained erosion in the value of their assets, caused by weakening markets for U.S. agricultural commodities and reduced expectations for future earnings. The debt-asset ratio for January 1, 1985, rose to 22.4 from 20.8 on January 1, 1984, due to a substantial decline in the value of farm real estate assets. Earlier this year, the January 1 debt-asset ratio was forecast to fall slightly to 20.7, based on a projected 2-percent reduction in the value of farm real estate assets and lower total farm debt. Recently published ERS estimates show that the value of farm real estate assets fell to $677 billion on January 1, 1985, down 12 percent from $764.5 billion a year earlier. Even though January 1 outstanding farm debt is projected to decline about 1 percent to $212.1 billion from $214.7 billion in 1984, the significant drop in the value of total farm assets (three-fourths of which is real estate) has caused the debt-asset ratio for January 1, 1985, to rise significantly from a year earlier. The 7.7-percent increase to 22.4 sustains the sharp upward trend that began between 1981 and 1982, reflecting continued deterioration in the domestic farm economy.

The overall decline in the value of farm assets is attributable in part to lower demand for U.S. agricultural commodities and the subsequent effect of reduced farm income. U.S. exports of agricultural commodities are expected to be down this year as world supplies are abundant, overseas crop production is at record levels, and U.S. export demand potential is diminished by the relatively high value of the U.S. dollar. The value of total U.S. agricultural exports is

projected to fall for the third successive year to $33.5 billion in fiscal year 1985, down 12 percent from $38 billion a year earlier.

Reduced commodity exports and expected near-record domestic crop production this year have caused crop prices to fall. Consequently, both net farm and net cash income are forecast to decline from year-earlier levels. Net farm income this year is expected to total $20 to $25 billion, compared with the preliminary $34.5 billion last year, while net cash income is projected to range between $34 and $38 billion compared to $38 billion in 1984.

The combined effect of lower farm income, burdensome debt, and sharply declining farm asset values more than offsets the benefit of lower interest rates and input prices. As a consequence, U.S. farmers are forecast to purchase $2.13–$2.20 billion of tractors in 1985, down 11 to 13 percent from last year's depressed $2.53 billion. Expenditures for all other farm machinery are projected to fall 7 to 10 percent from $4.75 billion in 1984 to between $4.27 and $4.40 billion. These estimates are significantly below February 1985 estimates, primarily because farm real estate values declined more than expected in early 1985. U.S. farmers could purchase up to $1 billion less farm machinery next year than is forecast to be bought in 1985, if real interest rates rise and cropland values fall.

As U.S. farmers purchase less new farm machinery for the sixth consecutive year, on-farm machinery needs are being met in other ways. In many areas of the country, particularly the Midwest, there is an abundance of good used farm machinery on the market at attractive prices. Midwest farmers and machinery dealers from surrounding areas have taken advantage of the availability of this used machinery, which has further dampened demand for new machinery.

Also, since 1982, farmers have spent relatively more repairing their machinery than they have purchasing machinery items. The farm machinery repair-to-capital purchase expenditure ratio for 1984 shows that for each dollar spent on machinery purchases, farmers spent 59 cents on machinery repairs, up from 32 cents in 1979.

Still, the value of the domestic farm machinery capital stock has declined in recent years as farmers have steadily purchased less new machinery. Capital consumption of farm machinery during the 1980's increasingly has exceeded the value of machinery purchases. Throughout the 1970's, farmers were adding to their machinery stocks, as annual capital expenditures were higher than capital consumption. Starting in 1980, however, machinery capital consumption was 9 percent greater than capital expenditures, and rose to about 65 percent higher between 1982 and 1984. Machinery capital consumption remained relatively constant at $12.3 to $13 billion between 1981 and 1984, while annual capital purchases continued to fall steadily from $10.2 billion in 1981 to the $6.4–$6.6 billion projection for this year. Until there is sustained improvement in the farm economy and demand for farm machinery rises, the aggregate value of farmers' aging machinery capital stock will continue to decline.

Unit Purchases

Although domestic demand for new farm machinery fell dramatically in 1984, U.S. farmers are expected to purchase even less machinery this year. Typically, annual demand for most farm tractors peaks in March and April just as field preparation and planting of most of the major field crops begin and again in the fall. Since 1973, U.S. farmers have made about 22 percent of their annual new tractor purchases in March and April. Even though farm tractor sales generally rise each year during the September–October field crop harvesting and winter wheat planting period, farm financial conditions and new tractor purchases in first-half 1985 suggest that aggregate domestic demand for tractors will be down from 1984's depressed level.

Domestic over-40 horsepower (hp) tractor sales this year are significantly below 1984 levels. Farm purchases of 40–99 hp two-wheel drive tractors during January–May 1985 totaled about 15,880 units, 8 percent below a year earlier (figure 1). Purchases of over 100 hp two-wheel drive tractors during the same period fell 19 percent from roughly 11,100 units in 1984 to about 8,950 units this spring (figure 4). But, the larger hp tractor market has been impacted more severely by the poor farm economy, as purchases of four-wheel drive tractors declined over 45 percent to

about 1,140 units during January–May 1985 from 2,085 units the previous year (figure 7).

U.S. farmers are forecast to buy significantly fewer tractors in 1985 than a year ago. Annual purchases of 40–99 hp two-wheel drive tractors are projected to fall 1.5 percent to 37,700 units this year, while over-100 hp two-wheel drive purchases are expected to be down about 8 percent to 22,600 units (table 2). Demand for four-wheel drive tractors will decline sharply this year, as farm purchases are forecast to fall 27 percent to 2,900 units.

Because of the projected purchase patterns, total power takeoff (PTO) capacity for new over-40 hp wheel tractor purchases is forecast to fall 23 percent to about 5.4 million hp from 6.94 million in 1984 (table 3). Total PTO hp purchased annually has declined steadily since 1979. Farmers who have been able to buy new tractors are purchasing less expensive, smaller-powered units. With farm demand for higher-powered tractors declining faster than demand for 40–99 hp units, the average per-unit capacity for new over-40 hp tractor purchases is projected to fall for the sixth consecutive year, dropping 4.5 percent from 104 hp in 1984 to 99.3 hp this year.

Seasonal purchasing patterns for grain harvesting, forage harvesting, and haying equipment differ from tractor demand patterns. Farmers make most of these equipment purchases during seasonal harvesting peaks. Demand for combines, corn heads, and forage harvesters rise sharply between September and November, while sales of balers, mower conditioners, and windrowers peak during the summer months.

Most grain harvesting, forage harvesting, and haying equipment purchases, which are at seasonal lows during the spring, also declined during January–May from 1984 levels. In particular, domestic self-propelled combine and corn head unit sales dropped 34 and 43 percent, respectively, to about 1,910 and 940 units (figures 13 and 16). Forage harvesting and haying equipment sales in early 1985 did not fall as drastically. Farmers purchased about 620 forage harvesters during January–May 1985, down 11.7 percent from the previous year (figure 19). Baler purchases fell 1 percent to about 2,310 units (figure 10); mower conditioners, 3 percent to 3,920 units (figure 22); and windrowers, about 11 percent to 595 units (figure 25).

For all of 1985, domestic farm purchases of grain and forage harvesting machinery also are projected to decline from recent levels, while haying machinery sales are forecast to remain about the same as last year. Purchases of self-propelled combines and corn heads are expected to drop about 27 percent to 8,400 and 4,700 units, respectively (table 2). Farmers also are projected to buy 2,800 forage harvesters, down 21 percent from about 3,540 units in 1984. Demand for haying equipment is expected to remain constant, with baler purchases increasing 1 percent to 8,400 units and mower conditioner purchases falling 1 percent to 12,950 units.

Supplies

Inventories

Domestic market inventories of the major farm machinery items are large and, for most implements, far exceed current and expected near-term demand. Faced with depressed demand since 1982, manufacturers have made a concerted effort, particularly since second-half 1984, to improve their balance sheets by reducing production and market inventories. Many plants were temporarily shut down during the past year and early 1985, with some not expected to reopen until inventories are reduced. Yet, virtually all major domestic manufacturers recently announced plans to further cut production of wheel tractors and combines during second-half 1985.

Current tractor inventories generally have risen from year-earlier levels. May inventories of 40–99 hp two-wheel drive tractors rose 2.6 percent to about 30,575 units from 29,785 units in 1984, but were well below 1978–80 and 1981–83 annual averages of 37,870 and 35,505 units, respectively (figure 2). Likewise, four-wheel drive tractor inventories in May rose 13 percent from 3,860 units in 1984 to about 4,360 units this year, but also were 19 to 34 percent below 1978–80 and 1981–83 levels (figure 8). Inventories of over-100 hp two-wheel drive tractors, however, have fallen significantly. The May inventory of large two-wheel drive tractors declined 20 percent to 25,910 units from a year earlier, and was 1.3 and 23.4 percent,

respectively, below 1978–80 and 1981–83 annual averages (figure 5).

Inventories of grain harvesting, forage harvesting, and haying machinery, on the other hand, have fallen sharply from recent levels. Self-propelled combine and corn head inventories (10,080 and 7,120 units) in May 1985 were 29 and 25 percent, respectively, below a year earlier and even further below 1978–80 and 1981–83 annual averages (figures 14 and 17). A similar pattern exists for balers, forage harvesters, and windrowers. May baler inventories stood at about 10,030 units, 7 percent below the 1984 level and a respective 54 and 34 percent under 1978–80 and 1981–83 average May inventories (figure 11). The May forage harvester inventory declined 22 percent to 5,285 units from 1984 (figure 20), while windrower inventories dropped 30 percent to 3,560 units (figure 26). Also, the May 1985 mower conditioner inventory of 18,000 units was significantly below 1978–83 averages and over 5 percent below the May 1984 level of 19,020 units (figure 23).

Inventory-to-purchase Ratios

In spite of industrywide efforts to reduce inventories, machinery supplies are large relative to present and recent U.S. demand trends. U.S. farm machinery manufacturers have not been successful during the past several years in pegging production levels to declining domestic demand. As a consequence, inventory-to-purchase ratios for most machinery items currently are at or near record highs.

Inventory-to-purchase ratios presented in this and subsequent Inputs reports compare domestic market inventory levels in a given month with total domestic sales during the same month plus the previous 11 months (ratios in this report are not comparable to those presented in Inputs Reports 5 through 7). By using a rolling annual average procedure, inventory-to-purchase ratios indicate how long present supplies would last relative to current and recent demand levels. For instance, an inventory-to-purchase ratio of 1.25 means that market supplies for the considered month are sufficient to satisfy 25 percent more demand than was realized during the previous year. In other words, there currently exists a 15-month supply of machinery.

It appears that tractor manufacturers have brought inventories of over-100 hp two-wheel drive units more in line with demand through cutting production than they have reducing inventories of smaller two-wheel drive and four-wheel drive units. Inventory-to-purchase ratios for 40–99 hp two-wheel drive tractors and four-wheel drive tractors continued to rise during early 1985, reaching respective records of 0.83 and 1.44 in May (figures 3 and 9). The sharp increases primarily reflect a severe drop in farm demand for tractors, particularly four-wheel drive units. The over-100 hp two-wheel drive inventory-to-purchase ratio for May 1985 is just under the May 1984 record of 1.17, as supplies have been reduced slightly faster than declining unit sales (figure 6).

Grain harvesting equipment manufacturers have substantially lowered production of self-propelled combines and corn heads. As a consequence, May inventory-to-purchase ratios for these categories fell about one-fifth from 1984 records to 0.97 and 1.25, respectively (figures 15 and 18). Producers of forage harvesting and most haying equipment also have been able to reduce inventories. The inventory-to-purchase ratio for forage harvesters fell to 1.53 in May 1985 from 1.73 a year earlier (figure 21), and the ratio for windrowers declined from 1.76 to 1.41 (figure 27). The inventory-to-purchase ratio for balers is relatively unchanged at 1.21 (figure 12), while the mower conditioner ratio rose from 1.33 to a near-record 1.39 (figure 24). Although forage harvesting and haying equipment production has been significantly reduced, supplies remain excessive.

An annual comparison of inventory-to-purchase ratios for May shows there currently is on hand a 10–18 month supply of new wheel tractors, grain and forage harvesting machinery, and haying equipment. May ratios for 40–99 hp two-wheel drive tractors and four-wheel drive tractors rose to record levels, while the over-100 hp two-wheel drive tractor ratio fell slightly (figure 28). Ratios for grain harvesting equipment, forage harvesters, and windrowers in May declined significantly from record highs, but ratios for balers and mower conditioners stand at or near alltime highs (figures 29 and 30). Based on comparisons with historical inventory-to-purchase ratios

and expressed individual company goals to increase efficiency and profitability, domestic manufacturers will have to lower production even further to reduce shortrun inventories and reduce longrun industrywide productive capacity.

Foreign Trade

The U.S. farm machinery foreign trade balance continued its 4-year decline through first-quarter 1985. The United States posted a positive trade balance of $6.5 million for the quarter, about 93 percent or $83.5 million below a year earlier (table 4). First-quarter farm machinery exports were down 15 percent to near $427 million, while the value of imports rose about 2 percent to $421 million from first-quarter 1984.

A major factor in the narrowing trade balance has been the large drop in exports of wheel tractors and parts, which represent roughly 49 percent of the total value of U.S. farm machinery exports. In first-quarter 1985, the total value of wheel tractor and parts exports fell more than 20 percent to $205 million, with exports to Canada and Australia dropping a respective 32 and 21 percent from the same period a year earlier. Also, wheel tractor and parts exports to several major Western European countries have fallen considerably because U.S. foreign farm machinery subsidiaries now obtain most of their wheel tractor components in Europe rather than from the United States.

Not only are wheel tractor and parts exports falling, but U.S. exports of every major farm machinery category, except planting and fertilizing equipment, are down from 1984. The declines range from a low of 4.7 percent for harvesting machinery to a high of 24.8 percent for poultry equipment. Except for Central America and Eastern Europe, farm machinery exports to traditional U.S. trade partners have dropped between 5.2 and 49.2 percent.

Exports to Central America are up primarily because of the lifting of monetary exchange restrictions in Mexico. During first-quarter 1985, the value of U.S. exports of wheel tractors and parts plus harvesting machinery to Mexico rose 1.3 and 7.2 times their 1984 level, respectively. Mexico accounted for $49 million, or 81 percent, of the $60.5 million of farm machinery exported to Central America. The 45-percent increase in the value of farm machinery exports to Eastern Europe during 1984 was due to increased tractor shipments to the Soviet Union.

Of more significance is the 22-percent decline in the value of farm machinery exports to Canada. Canada is not only the United States' major export market for wheel tractors and harvesting machinery, but also for haying and mowing machinery, plows and cultivators, and planting and fertilizing equipment, which declined about 25 percent from last year. Although the flow of U.S. farm machinery to Canada is affected by the high value of the U.S. dollar, trade with Canada appears to hinge more on changes in Canadian farm structure and the financial condition of the Canadian farm sector. Also, Canada is now a replacement rather than a growth market for new machinery, making the opportunity for any appreciable export growth above historic levels unlikely.

While the market for high-valued U.S. farm machinery exports continues to weaken, the relatively high value of the U.S. dollar continues to be one of the major factors behind the increase in farm machinery imports. Shipments from Western Europe, Japan, and Canada accounted for over 87 percent of the value of U.S. farm machinery imports in the first quarter of 1985. Underlying the rise in imports from Japan and Western Europe is increased domestic demand for small (under-40 hp) and mid-sized (40-99 hp) two-wheel drive tractors produced by both U.S. subsidiaries and private foreign firms. These tractor imports represent about 55 percent of the total value of U.S. farm machinery imports.

Trends in Farm Machinery Trade

The domestic farm machinery industry has undergone significant structural changes during the past decade. The industry has responded to declining domestic and export demand by lowering production, cutting employment, and reducing or forgoing new capital expenditures. To reduce costs, manufacturers also have narrowed their product lines and relied more on foreign-based manufacturers to produce all or portions of their products. Sourcing of component parts

and assembled machinery from abroad has become an increasingly favorable strategy as domestic manufacturers take advantage of lower foreign labor and raw material costs and the absence of any trade duties on farm machinery entering the United States.

As a result, the value of farm machinery imports has increased as a share of the total domestic machinery supply. In 1972, farm machinery imports represented less than 10 percent of the net domestic supply, but between 1977 and 1984, the value of imports rose 80 percent and the share of imports to the total net domestic supply climbed from 10 to 17 percent (figure 31).

The U.S. farm machinery trade balance peaked at $1.4 billion in 1981 (figure 32). At that time, domestic manufacturers exported $1.9 billion of farm machinery for every $1 billion imported. The ratio of machinery exports to imports peaked at $2.02 billion to $1 billion in 1982. However, the differential started to narrow significantly thereafter, falling from $1.02 billion to $506 million in 1984. First-quarter 1985 trade values suggest that the trade balance will continue to fall.

The sharp increase in the demand for small tractors for nonagricultural uses, coupled with the influx of part-time farmers into U.S. agriculture, has increased the demand for small- to mid-size tractor imports in recent years. Under-40 hp wheel tractor imports account for roughly 30 percent of all U.S. farm machinery imports. The value of all tractor and parts imports equaled about $1.2 billion, or 71 percent of the value of all U.S. farm machinery imports in 1984. The United States imported roughly 56,000 under-40 hp wheel tractors in 1984 (figure 33). Japanese imports accounted for 50,000 units, or 89 percent of the total.

After declining to a low of 20,000 units in 1982, 40-99 hp tractor imports increased to a 6-year high of 41,000 units in 1984 (figure 34). Western Europe accounted for roughly 70 percent of these imports last year. However, Japanese firms are now manufacturing mid-size wheel tractors. Imports from Japan more than doubled to 9,550 units in 1984 from a year earlier, accounting for almost 25 percent of all mid-sized tractor imports. This trend is expected to continue as the Japanese become more cost competitive in mid-size tractor production and more established in the U.S. market.

Large hp tractors historically have been demanded by farmers in the United States, Canada, and Australia. Consequently, production of over-100 hp wheel tractors has been primarily confined to North American manufacturers. However, the United States imported about 4,000 over-100 hp wheel tractors in 1984, up 82 percent from the previous 4-year average of 2,300 units (figure 35). Firms located in Western Europe, either foreign-owned or U.S. subsidiaries, accounted for 75 percent or 3,100 of these tractors. Although 4,000 units represent a relatively small share of the domestic large hp tractor market, the sharp rise indicates a shift by European-owned firms and U.S. foreign subsidiaries to actively produce and export large hp tractors to the United States. Large hp tractor imports probably will be constrained by the current weak demand in the North American tractor market.

From 1972 to 1981, the value of U.S. farm machinery exports grew at an annual average rate of 24 percent. Since 1981, however, the value has declined an average of 7.8 percent per year. Much of the decrease is due to a dwindling foreign market for high-valued farm machinery, such as over-100 hp wheel tractors and self-propelled combines. Exports of these items in 1984 declined a respective 23 and 46 percent from the peak export period of 1979 to 1981 (figures 35 and 36).

There is also some indication that farm machinery exports to Saudi Arabia, which totaled $700 million over the past 3 years, have peaked. So far this year, the value of exports to Saudi Arabia is down 22.5 percent from last year (table 4). Over the past 3 years, Saudi Arabia was a chief importer of U.S. spray and irrigation equipment to fulfill goals set in its agricultural development program. Exports to Saudi Arabia should decline as this program reaches completion.

In summary, the current outlook for the U.S. farm machinery trade situation will be affected by increased growth in the value of imports and a leveling off or declining growth in the value of exports, indicating a further erosion of the positive U.S. farm machinery trade balance. The current structure and financial condition of North American

agriculture suggests minimal growth in the demand for new machinery in the near-term, especially for large tractors and self-propelled combines. Farmers purchasing new tractors are opting for lower hp models. This trend has had a decidedly negative impact on the U.S. farm machinery trade balance because production of low hp tractors has been virtually discontinued by domestic producers. Likewise, U.S. foreign subsidiaries are now supplying most of the tractor components needed to produce these machines intead of importing them from the United States. Comparative advantages in labor and raw material costs held by overseas manufacturers encourage this strategy.

The relatively high value of the U.S. dollar on the world market, the lack of potential growth in traditional foreign markets, and the heavy indebtedness of developing countries is a hindrance to the expansion of U.S. farm machinery exports. With developing countries offering the principal area for significant trade growth, domestic manufacturers will likely explore new areas of machinery design and production to take advantage of the potential switch from labor intensive to capital intensive agricultural production practices once these developing countries become more financially stable.

Table 1--Trends in U.S. farm machinery expenditures and factors affecting machinery demand

Item	1979	1980	1981	1982	1983	Preliminary 1984	Projected 1985
				Billion dollars			
Capital expenditures:							
Tractors	3.75	3.68	3.74	2.88	2.77	2.53	2.13-2.20
Farm machinery	8.00	6.96	6.48	5.10	4.85	4.75	4.27-4.40
Total	11.75	10.64	10.22	7.98	7.62	7.28	6.40-6.60
Other expenditures:							
Tractor and machinery repairs	3.74	3.75	3.77	3.86	3.97	4.29	na
Tractor depreciation	3.18	3.62	4.09	4.05	3.87	3.54	3.40
Farm machinery depreciation	7.20	7.99	8.58	8.92	8.91	8.75	8.20
Factors affecting demand:							
Interest expenses	13.06	16.26	19.86	22.18	21.24	21.10	21.00
Total production expenses	118.05	128.94	136.89	139.48	135.32	139.20	138.00
Outstanding farm debt 1/	140.80	165.80	182.00	201.70	216.30	214.70	212.10
Farm real estate assets 1/	655.00	755.90	828.40	818.90	769.20	764.50	677.00
Agricultural exports 2/	31.98	40.48	43.78	39.10	34.77	38.03	33.50
Net farm income 3/	32.30	21.20	31.00	22.30	16.10	34.50	20.0-25.0
Net cash income 3/	37.50	37.70	35.00	36.80	40.10	38.00	34.0-39.0
				Percent 4/			
Real prime rate	4.03	6.09	9.24	8.84	6.95	8.37	6.27
Real PCA interest rate 5/	1.92	3.56	4.83	8.56	8.11	8.69	7.79
Real non-real estate operating loan rate 6/	2.16	5.64	8.24	11.06	10.46	10.74	9.53
				Ratio			
Debt-asset ratio	16.10	16.50	16.70	18.60	20.70	20.80	22.40
Repair-to-capital expenditure ratio 7/	0.32	0.35	0.37	0.48	0.52	0.59	na
Depreciation-to-capital expenditure ratio 8/	0.88	1.09	1.24	1.63	1.68	1.69	1.76-1.81

na = not available

1/ Calculated using nominal dollar balance sheet data, including farm households, for January 1 of each year. 2/ Fiscal year. 3/ Data for 1984 are midpoints for forecasted ranges. 4/ Deflated using the GNP implicit price deflator (1972=100). 5/ Production Credit Association. 6/ Short-term rate reported by agricultural banks in the Ninth (Minneapolis) Federal Reserve District. The 1985 rate is a January-June average. 7/ Tractor and machinery repair expenditures divided by total farm machinery capital expenditures. 8/ Tractor and farm machinery depreciation expenditures divided by total farm machinery capital expenditures.

Table 2--Domestic farm machinery purchases

Machinery category	Annual average 1978-80	1981-83	1984	Projected 1985	Change 1984-85
	Units				Percent
Tractors:					
Two-wheel drive--					
40-99 hp	62818	43421	38260	37700	-1.5
Over-100 hp	59543	33528	24505	22600	-7.8
Four-wheel drive	10276	7188	3975	2900	-27.0
Grain and forage harvesting equipment:					
Self-propelled combines	29834	18594	11437	8400	-26.6
Corn heads	20338	10608	6419	4700	-26.8
Forage harvesters 1/	11145	5611	3538	2800	-20.9
Haying equipment:					
Balers 2/	17501	10528	8315	8400	1.0
Mower conditioners	23392	15586	13057	12950	-0.8

1/ Shear bar type. 2/ Producing bales up to 200 pounds.

Source: Farm and Industrial Equipment Institute (FIEI). May 1985 U.S. Retail Sales of Wheel Tractors and Selected Machinery and previous monthly reports. Data presented in farm machinery unit sales and inventory graphs are from FIEI.

Table 3--Power estimates for farm purchases of new over-40 horsepower wheel tractors

Year	Total PTO horsepower 1/ Million	Percent change	Average PTO horsepower Per unit	Percent change
1973	15.34		97.9	
1974	14.43	-5.9	101.0	3.2
1975	14.67	1.7	105.8	4.8
1976	14.32	-2.4	104.3	-1.4
1977	13.71	-4.3	104.7	0.4
1978	15.11	10.2	108.3	3.4
1979	15.30	1.3	110.1	1.7
1980	13.22	-13.6	110.8	0.6
1981	11.51	-12.9	110.8	0
1982	8.37	-27.3	108.3	-2.2
1983	7.68	-8.2	107.6	-0.7
1984	6.94	- 9.6	103.9	-3.4
Projected 1985	5.38	-22.5	99.3	-4.5

1/ PTO refers to power takeoff.

Table 4--Farm machinery trade situation 1/

Trade, area	January-March 1984	1985	Change 1984-85
	Million dollars		Percent
Exports to:			
Africa	36.6	18.6	-49.2
Australia	36.8	34.9	-5.2
Canada	232.3	181.2	-22.0
Central America 2/	25.2	60.5	140.0
Eastern Europe	5.8	8.4	44.8
Far East	15.8	12.1	-23.4
Middle East	7.0	6.4	-8.6
Near East	4.1	2.4	-41.5
Oceania	1.3	0.9	-30.8
Saudi Arabia	29.8	23.1	-22.5
South America	20.5	18.5	-9.8
Western Europe	87.8	60.3	-31.3
Total	503.0	427.3	-15.0
Imports from:			
Africa	0.1	0.3	200.0
Canada	135.3	108.6	-19.7
Central America 2/	2.9	1.2	-58.6
Eastern Europe	8.0	5.2	-35.0
Far East 3/	1.8	3.5	100.0
Italy	35.4	32.1	-9.3
Japan	83.4	95.7	14.7
Middle East	1.9	2.5	31.6
Near East	0.1	0.1	0
Oceania	5.6	4.6	-17.9
South America	3.2	4.7	46.9
United Kingdom	52.6	63.4	20.5
West Germany	44.1	57.4	30.2
Western Europe 4/	38.6	41.5	7.5
Total	413.0	420.8	1.9
Trade balance	90.0	6.5	-92.8

1/ Includes finished machinery items, nonassembled machinery, and parts. 2/ Includes Caribbean countries. 3/ Excluding Japan. 4/ Excluding Italy, the United Kingdom, and West Germany.

Source: U.S. Department of Commerce. Trade Development, Office of Special Industrial Machinery.

40-99 HP Two-Wheel Drive Tractors

1978-80 Average   1981-83 Average
1984   1985

Figure 1
Sales
Thousand units

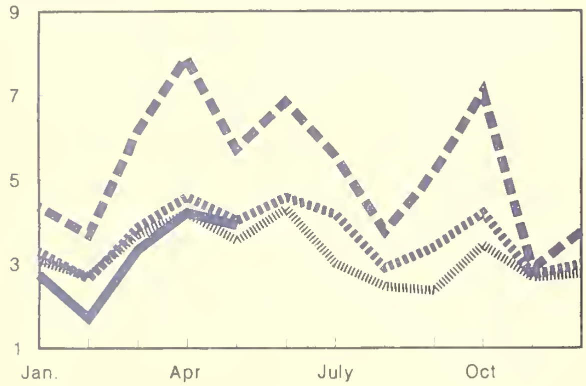


Figure 2
Inventories
Thousand units

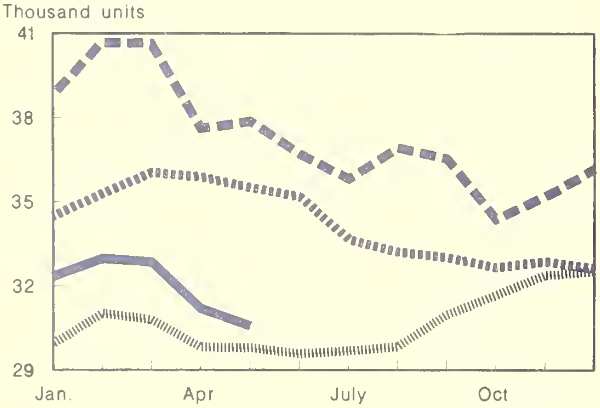
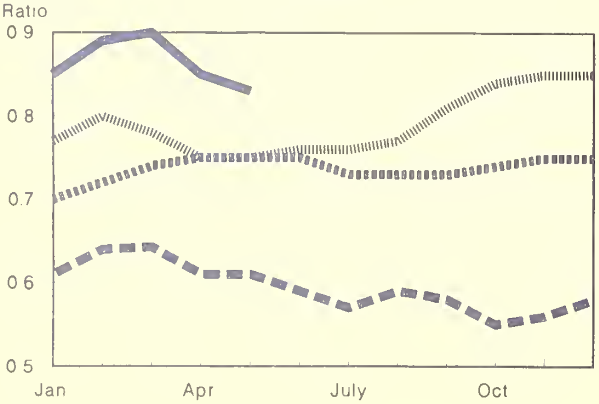


Figure 3
Inventory to Purchase Ratios
Ratio



Over-100 HP Two-Wheel Drive Tractors

1978-80 Average   1981-83 Average
1984   1985

Figure 4
Sales
Thousand units

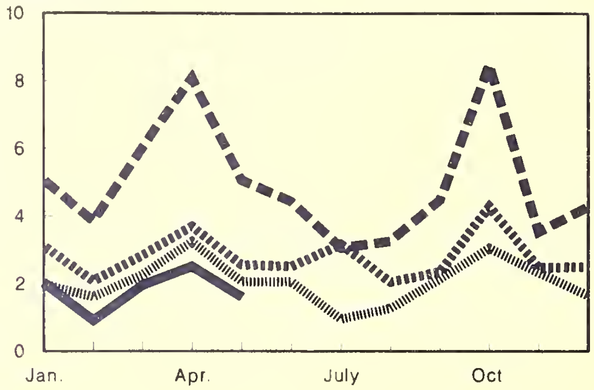


Figure 5
Inventories
Thousand units

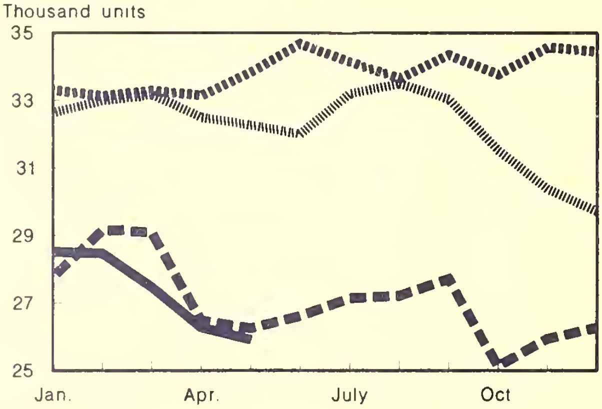
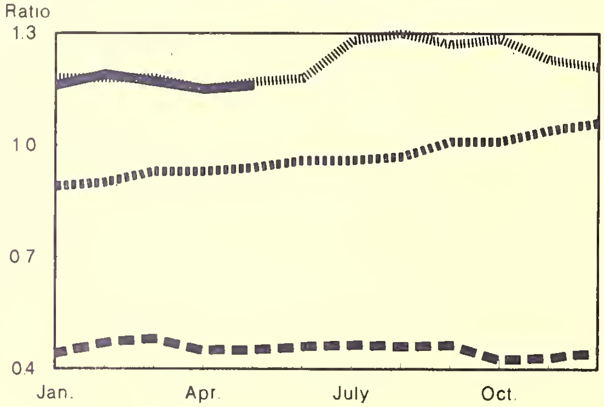


Figure 6
Inventory to Purchase Ratios
Ratio



Four-Wheel Drive Tractors

1978-80 Average | 1981-83 Average
1984 | 1985

Figure 7
Sales
Thousand units

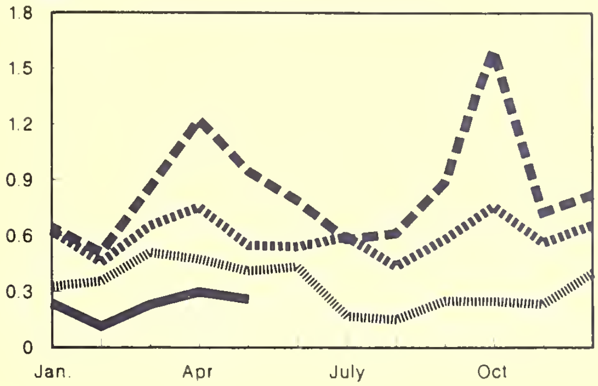


Figure 8
Inventories
Thousand units

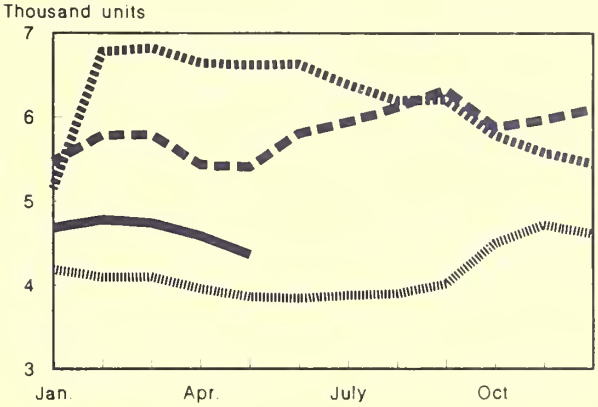
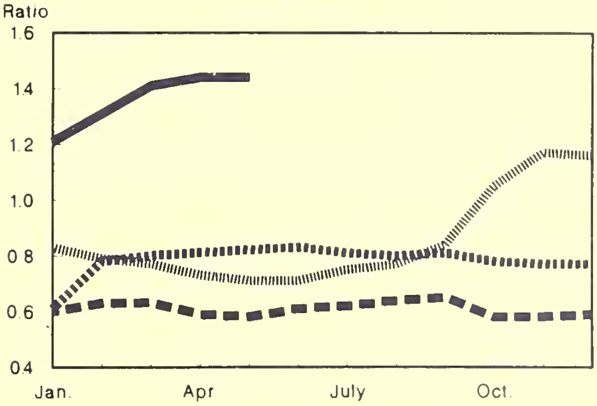


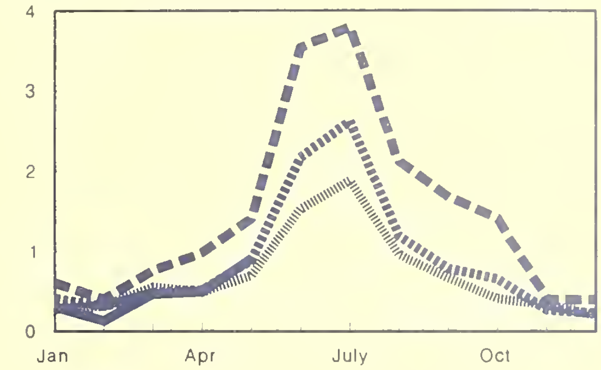
Figure 9
Inventory to Purchase Ratios
Ratio



Balers[1]

1978-80 Average | 1981-83 Average
1984 | 1985

Figure 10
Sales
Thousand units



1/ Producing bales up to 200 pounds

Figure 11
Inventories
Thousand units

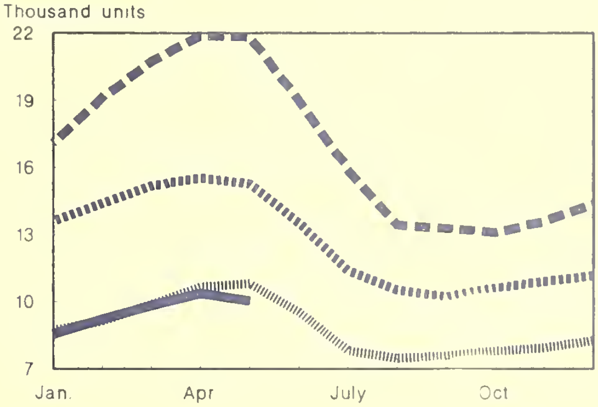
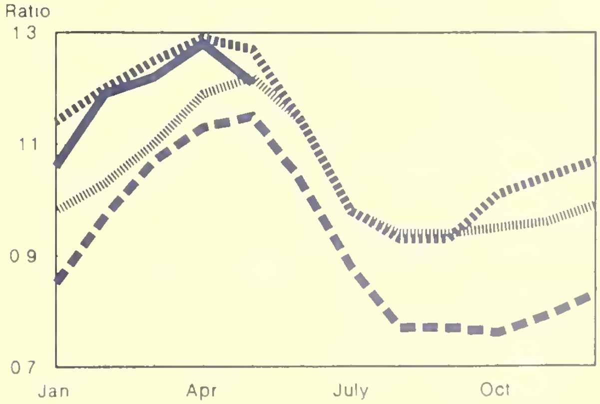


Figure 12
Inventory to Purchase Ratios
Ratio



Self-Propelled Combines

1978-80 Average | 1981-83 Average | 1984 | 1985

Figure 13

Sales

Thousand units

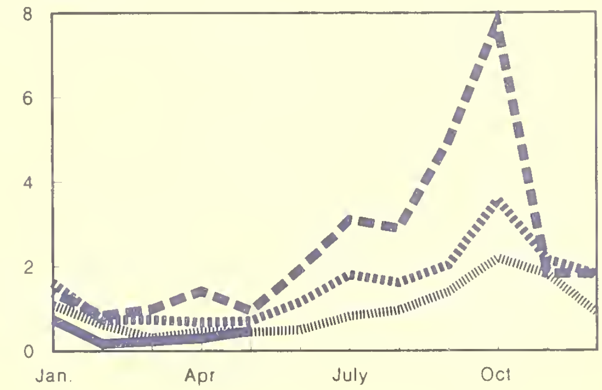


Figure 14

Inventories

Thousand units

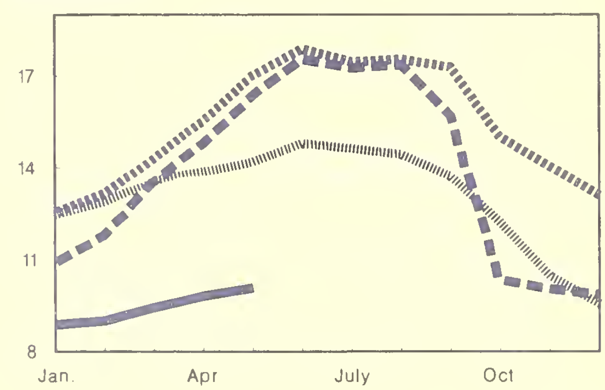
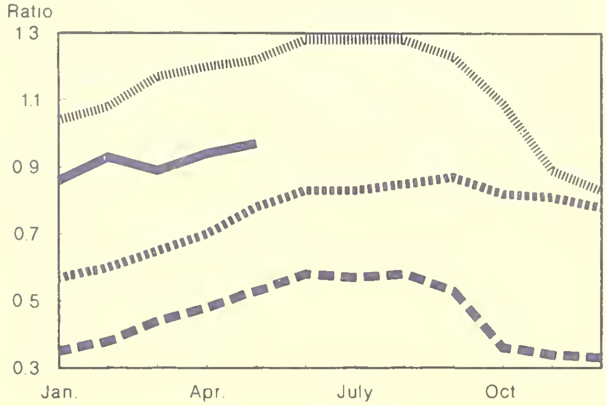


Figure 15

Inventory to Purchase Ratios

Ratio



Corn Heads

1978-80 Average | 1981-83 Average | 1984 | 1985

Figure 16

Sales

Thousand units

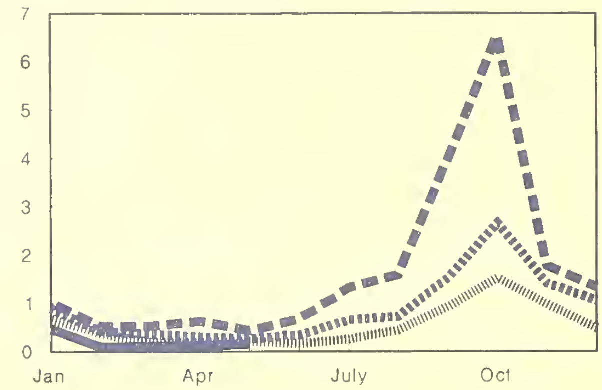


Figure 17

Inventories

Thousand units

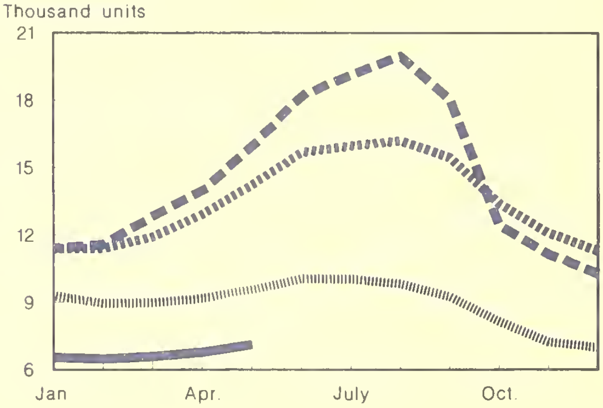
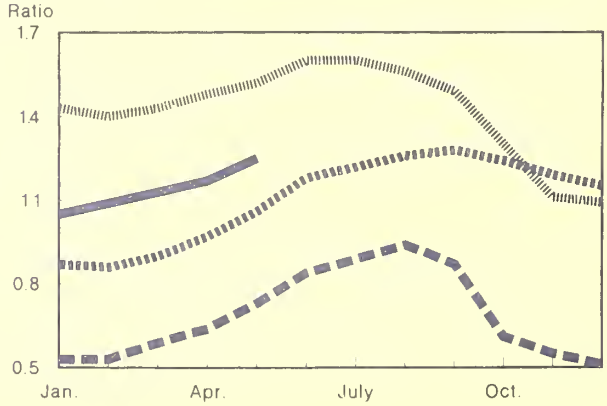


Figure 18

Inventory to Purchase Ratios

Ratio



Forage Harvesters

1978-80 Average — 1981-83 Average — 1984 — 1985

Figure 19
Sales

Thousand units

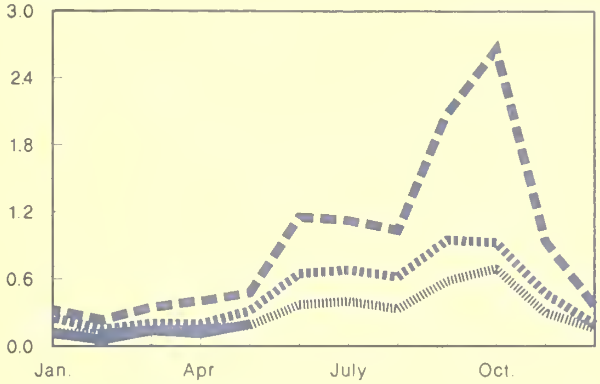


Figure 20
Inventories

Thousand units

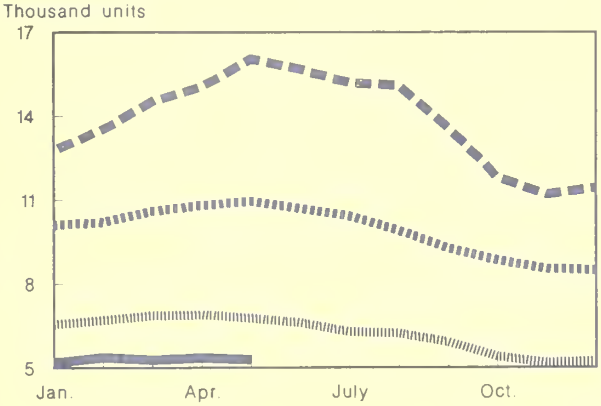
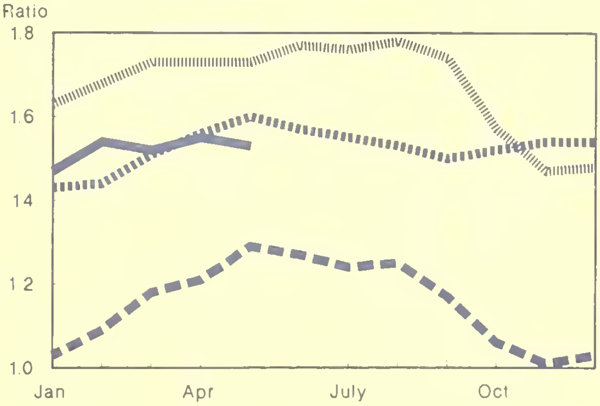


Figure 21
Inventory to Purchase Ratios

Ratio



Mower Conditioners

1978-80 Average — 1981-83 Average — 1984 — 1985

Figure 22
Sales

Thousand units

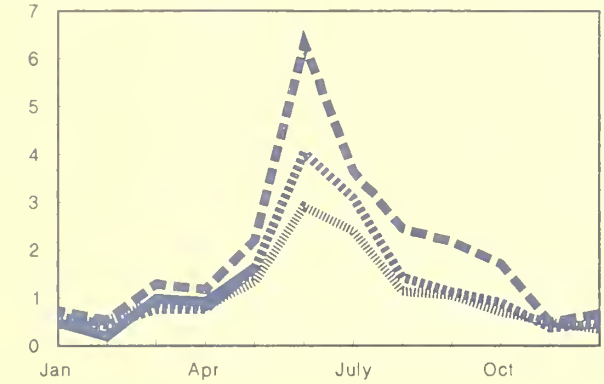


Figure 23
Inventories

Thousand units

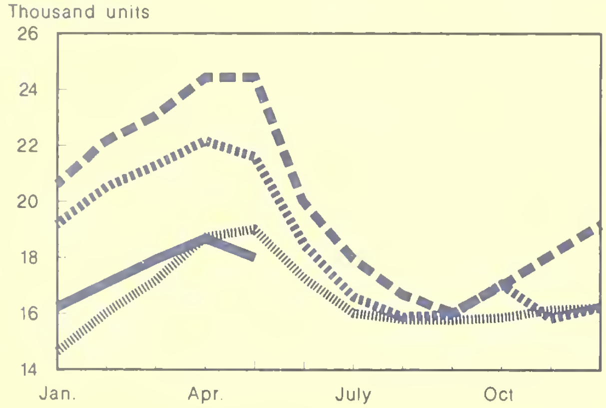
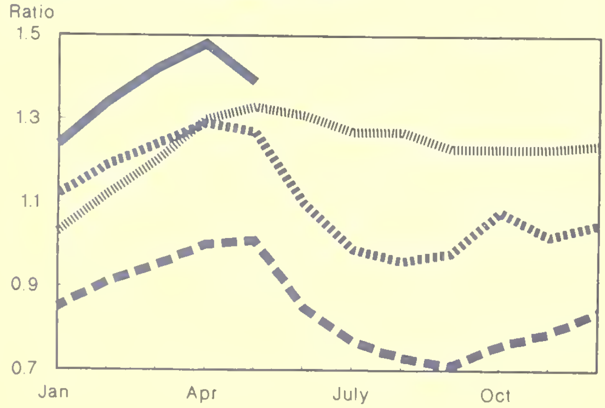


Figure 24
Inventory to Purchase Ratios

Ratio



Windrowers

1978-80 Average | 1981-83 Average
1984 | 1985

Figure 25
Sales

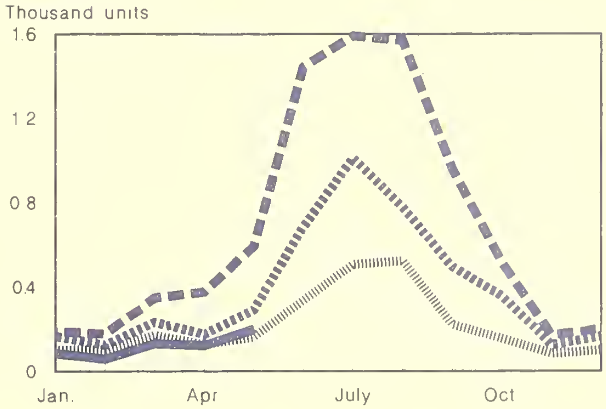


Figure 26
Inventories

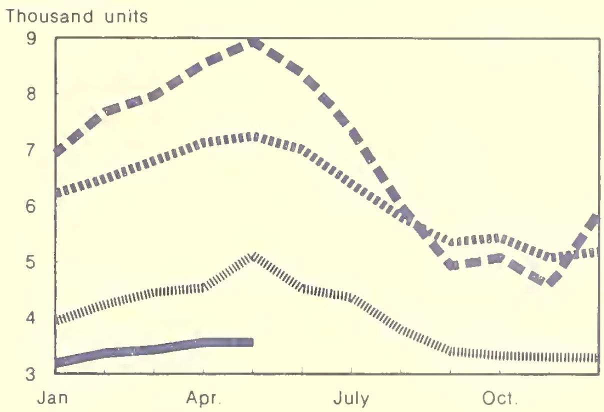
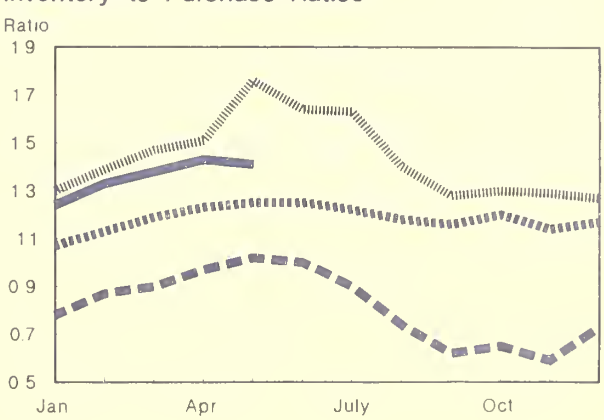


Figure 27
Inventory to Purchase Ratios



May Inventory to Purchase Ratios

Figure 28
Tractors

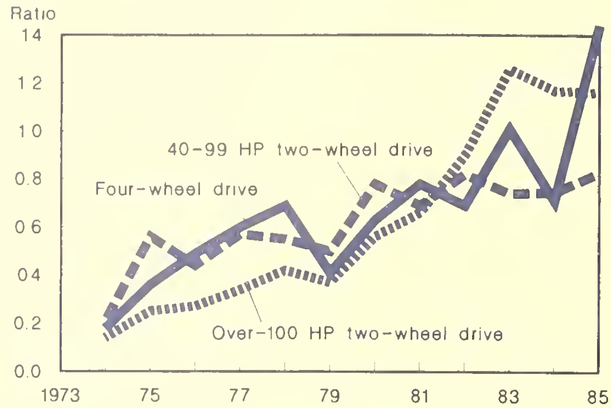
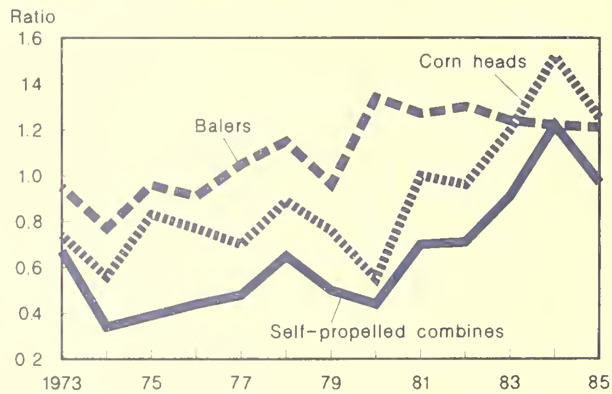


Figure 29
Balers, Corn Heads, Self-Propelled Combines[1]



1/ Balers producing bales up to 200 pounds

Figure 30
Forage Harvesters, Mower Conditioners, Windrowers

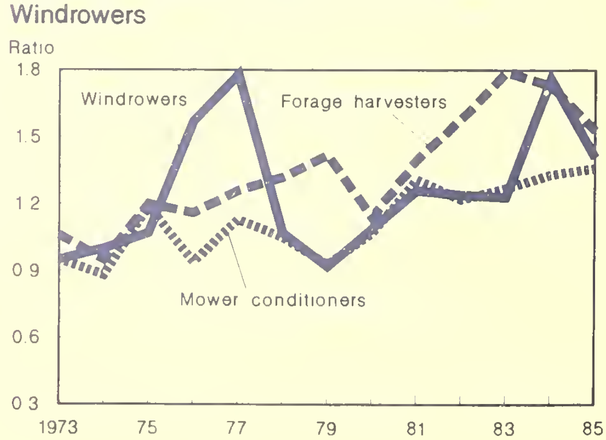


Figure 31

U.S. Farm Machinery Imports to Net Domestic Supply Ratio

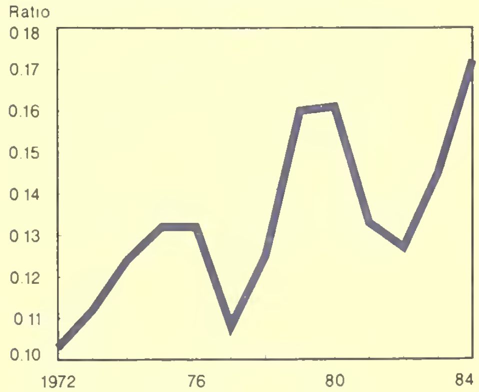


Figure 34

U.S. Imports of 40-99 HP Wheel Tractors

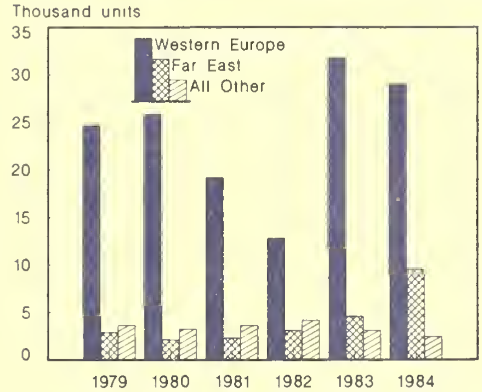


Figure 32

U.S. Farm Machinery Trade

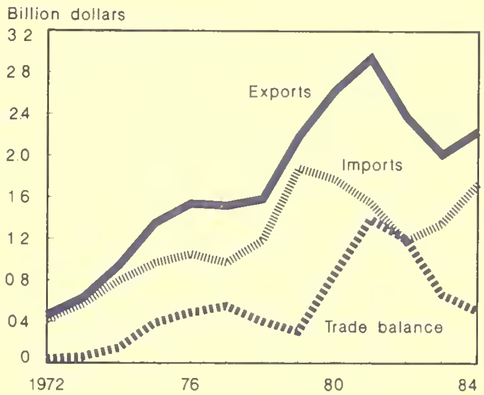


Figure 35

Over-100 HP Wheel Tractor Trade

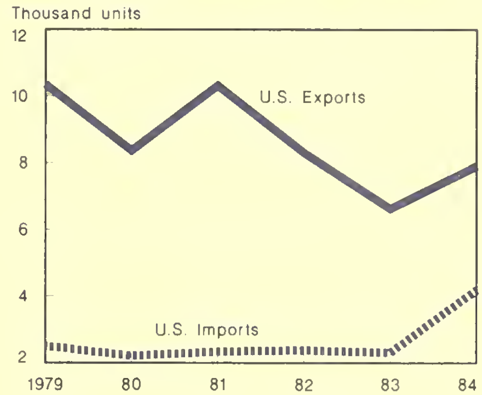


Figure 33

U.S. Imports of Under-40 HP Wheel Tractors

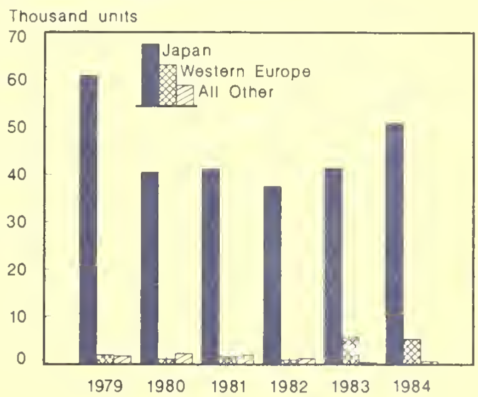
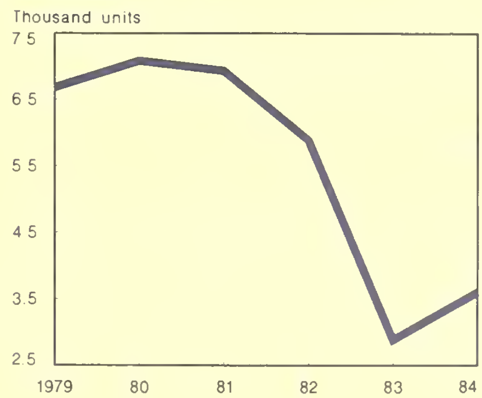


Figure 36

U.S. Exports of Self-Propelled Combines



ENERGY

World Oil Market

Demand

Prices paid by U.S. farmers for refined petroleum products are determined to a large extent by world oil prices, which, in turn, reflect world supply and demand conditions. World oil demand is projected to grow 1 to 2 percent in 1985, a slight decrease from the 1984 rate. This reflects projected slowing of economic growth, increasing energy conservation efforts, and substitution of other fuels for oil during 1985.

Petroleum demand in the market economies is projected to increase 0.4 percent (about 200,000 barrels per day) during 1985. Among market economies, petroleum demand in the developing countries is expected to pick up in 1985 and in the first half of 1986 if economic conditions in these countries improve.

Crude Oil Production

World oil production increased to 54 million barrels per day in 1984, the first increase since 1979. Although production was up 2 percent from 1983 levels, it was 14 percent below the 1979 peak.

While the Organization of Petroleum Exporting Countries (OPEC) accounted for nearly one-half of world oil production in 1979, its share declined to 33 percent by 1984. OPEC oil production is projected to decrease during 1985, while non-OPEC production is expected to increase. Net oil exports from the centrally planned countries are projected to decline. The total supply of oil available to the market economies is expected to remain unchanged in 1985 compared with a nearly 3-percent increase between 1983 and 1984.

Prices

Following substantial decreases in 1983, prices for nearly all major crude oils remained constant in 1984. Petroleum product prices are expected to decline in 1985, following the decrease in world oil prices in the first quarter of 1985.

Weakening of the OPEC cartel and actions by non-OPEC producers are expected to continue to exert downward pressure on world crude oil prices, despite a small increase in demand in 1985. The official price for Saudi Light has already been reduced from $29 to $28 per barrel. It appears unlikely that the OPEC benchmark price of $28 a barrel will be maintained since free market prices currently are running below the OPEC rate. To support oil prices, OPEC has attempted to keep production close to its self-imposed quota (16 million barrels per day) and reduce the differential between its official contract prices of heavy and light crude oil. Widespread quota violations and price cutting have been reported. It appears that world oil prices are increasingly determined by supply and demand rather than by OPEC strategies.

U.S. Energy Outlook

The U.S. energy picture for 1985 is projected to be somewhat different from 1984, mainly because of an assumed slowing in the growth of real Gross National Product from 6.8 percent in 1984 to 3.1 percent. As a result, much slower growth in energy demand is expected. Total U.S. energy consumption is projected to rise 2 percent to 75.3 quadrillion Btu in 1985, whereas 1984 energy consumption of 73.5 quadrillion Btu was up 4.6 percent from 1983. Energy demand is projected to rise only 1 percent between first-half 1985 and the first half of 1986.

Energy intensity is projected to decline to 44,600 Btu per dollar of real GNP (1972) in 1985 from 45,000 Btu in 1984. A further slight decline in the energy/GNP ratio is expected from the first half of 1985 to the first half of 1986, reflecting continued energy conservation.

Energy production in the United States set an alltime record of 65.5 quadrillion Btu in 1984, up 4.3 quadrillion Btu from 1983 and 0.8 quadrillion Btu above the previous peak in 1980. Increased production of every major energy source except hydroelectric power contributed to the record production. Of the total increase, coal and natural gas contributed 56 percent and 27 percent, respectively, while nuclear power accounted for 8 percent. Contributions from crude oil and natural gas liquids were 5 percent and 4 percent, respectively. However, there was a

continuing shift away from the use of oil and natural gas towards the use of nuclear energy and coal in the generation of electricity.

U.S. Energy Sources

Petroleum remains the most significant U.S. energy source, accounting for 42 percent of the 1984 total with natural gas and electricity at 24 and 10 percent, respectively. Natural gas use is projected to rise to nearly 18 trillion cubic feet in 1985, an increase of almost 3 percent from 1984. This projection assumes a continuation of economic growth and only moderate increases in natural gas prices during 1985. Natural gas production is expected to remain stable at about 17.2 trillion cubic feet in 1985. Total electric power generation is projected to increase by 3 percent in 1985, while prices are expected to increase 2 percent.

Domestic petroleum production is expected to increase slightly (1.1 percent) from 11 million barrels per day in 1984 to 11.1 million barrels in 1985. Total U.S. petroleum production is projected to remain unchanged in the first half of 1986.

U.S. petroleum demand in 1985 is projected to decline slightly (0.8 percent) after increasing 3 percent in 1984 (table 5). Rapid economic growth during 1984, stable crude oil prices, and a much colder winter than 1983 contributed to the turnaround in petroleum demand in 1984. The projected decline in petroleum demand is partly due to fuel switching in response to earlier petroleum price increases and continued improvements in fuel efficiency.

Consumption of all major petroleum products except residual fuel oil was greater in 1984 than in 1983. Residual fuel oil consumption declined for the seventh consecutive year and is expected to decline about 15 percent in 1985. Most of the decline was due to continued substitution of coal and nuclear energy for residual fuel oil in electricity generation. Motor gasoline demand in 1985 is expected to increase less than 1 percent from 1984, to 6.8 million barrels per day. Distillate fuel oil consumption is projected to increase only 2.5 percent, following a 6-percent jump in 1984 that resulted primarily from increased industrial production.

Net oil imports, excluding the Strategic Petroleum Reserve (SPR), are expected to fall 2.2 percent in 1985 from 4.5 million barrels per day in 1984 to 4.4 million (table 5). The share of net imports (excluding SPR) in the total supply is projected to be 1 percentage point lower than in 1984. These projections assume that the price of imported crude oil will decline by 3.4 percent (in nominal terms); the real gross national product will rise 3.1 percent; and no serious disruption of world oil markets occurs.

Farm Energy Use and Expenditures

Although farm energy use constitutes only a small fraction of total U.S. energy use, it is a very critical farm input. Even though energy supplies have been plentiful and energy prices have been moderate in recent years, farmers have continued to adopt energy-conserving techniques to reduce their operating costs.

Farm energy use in 1985 is expected to decline 2 percent. The projected decline is largely due to continued improvements in farm production technology designed to achieve reduced energy use per unit of output. These improvements include adoption of energy-conserving practices in tillage and crop drying. The reduction in energy use also reflects a slight reduction in acreage planted in 1985.

On-farm gasoline use has continued to decline while LP gas use changed little (figure 37). Diesel use, however, continues to

Figure 37
Farm Fuel Use

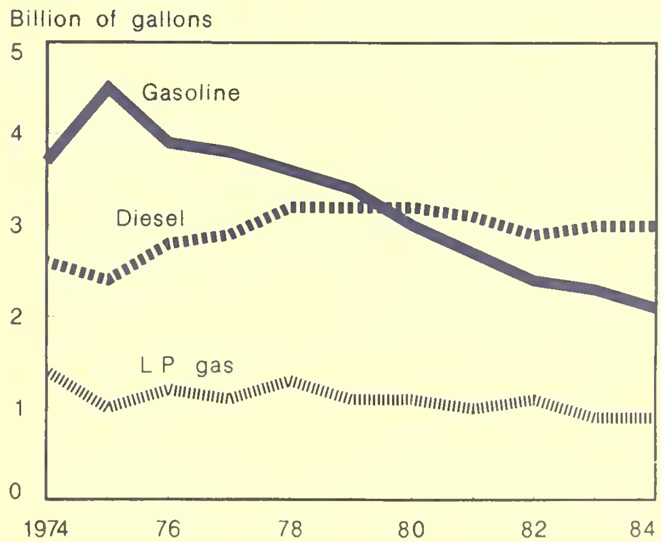


Table 5--U.S. petroleum supply-demand balance

Item	1982	1983	1984	1985	Projections 1986 1st quarter	Projections 1986 2nd quarter
	Million barrels per day					
Consumption:						
Motor gasoline	6.54	6.62	6.70	6.76	6.30	6.82
Diesel fuel	2.67	2.69	2.85	2.92	3.17	2.83
Residual fuel	1.72	1.42	1.36	1.16	1.44	1.02
Other	4.37	4.50	4.80	4.74	4.82	4.65
Total	15.30	15.23	15.71	15.58	15.72	15.32
Supply:						
Production	10.78	10.79	10.99	11.11	11.18	11.11
Net imports (excludes SPR)	4.13	4.08	4.46	4.36	3.82	4.52
Net stock withdrawals	0.32	0.25	-0.08	0.11	0.73	-0.32
Total primary supply	15.23	15.12	15.37	15.58	15.73	15.31
	Percent change from previous year					
Consumption		-0.5	3.1	-0.8		
Production		0.1	1.9	1.1		
Net imports		-1.2	9.3	-2.2		
Net import as share of U.S. supply		27.0	29.0	28.0		

SPR = Strategic Petroleum Reserves.

Source: U.S. Department of Energy, Energy Information Administration. Short-Term Energy Outlook. DOE/EIA - 0202 (85/2Q), May 1985.

increase relative to both gasoline and LP gas as older gasoline-powered machinery is replaced by new diesel-powered machinery. Farm use of gasoline has declined 9 percent, whereas diesel fuel and LP gas use have remained unchanged from year-earlier levels.

Farmers' energy expenditures declined from $9.6 billion in 1983 to $9.2 billion in 1984, even though the area planted to principal crops increased from 310 million to 345 million acres in 1984. The decline is due to energy consevation efforts and a drop in the prices of gasoline and LP gas. Even though the 344 million acres planted in 1985 is near the year-earlier level, energy expenditures are projected to decline further because of continued energy conservation and substitution of other inputs for energy.

Prices

Petroleum product prices are expected to decline during 1985 from last year, following the decrease in world oil prices during the

Table 6--Average U.S. farm fuel prices

Period	Gasoline 1/	Diesel fuel	LP gas
	Dollars per gallon		
1977	.57	.45	.39
1978	.60	.46	.40
1979	.80	.68	.44
1980	1.15	.99	.62
1981	1.29	1.16	.70
1982	1.23	1.11	.71
1983	1.18	1.00	.77
1984	1.16	1.00	.76
1985			
1st	1.09	.95	.74
2nd	1.17	.97	.73
3rd 2/	1.15	.96	.75
4th 2/	1.13	1.00	.78

1/ Bulk delivered regular. 2/ Projected using first-quarter farm prices as reported in Agricultural Prices, SRS, USDA and percentage price changes for gasoline and No. 2 heating oil (for diesel and LP gas) reported in Short-Term Outlook (85/2Q), Energy Information Administration, DOE.

first quarter. However, natural gas and electricity prices are projected to increase in nominal terms, but by less than the rate of inflation. Average farm prices of gasoline and LP gas declined slightly from 1983 to 1984, while the price of diesel remained unchanged (table 6). During 1984, farmers paid an average of $1.16 per gallon for bulk-delivered gasoline, $.76 per gallon for LP gas, and $1.00 per gallon for diesel. Average farm gasoline and diesel prices have declined substantially relative to their 1981 peaks. Electricity prices to nonindustrial consumers are expected to increase, on average, about 2 percent in 1985.

Natural gas prices are projected to increase only moderately during 1985 and first-half 1986. No substantial change in the nominal price of natural gas is anticipated because of the partial deregulation of natural gas that went into effect in January 1985.

Impacts of Lead Phase-Down

On July 1, 1985, the Environmental Protection Agency (EPA) reduced the amount of lead permitted in leaded gasoline from 1.1 grams per gallon to 0.5 grams. A further reduction to 0.1 grams on January 1, 1986, is required. The U.S. Department of Energy estimated that these restrictions will add one cent per gallon to gasoline prices from July on and another cent per gallon next January. The farm fuel price projections presented in table 6 have taken these impacts into account.

Lead in gasoline serves two functions; it is an octane enhancer and a lubricant for valves and valve seats. There are alternatives for lead's octane enhancing properties, one of which is ethanol. If domestically-produced corn-based ethanol is used to an appreciable extent, farmers could expect some upward movement of grain prices.

EPA also is considering banning lead completely at a later date. Many farmers may be affected if a complete lead ban is imposed. Although virtually all wheel tractors, combines, and many other types of farm equipment manufactured today are diesel-powered, a large number of gasoline-powered units still are used on farms. Equipment manufacturers, farm machinery trade associations, and USDA engineers generally agree that gasoline containing 0.1 to 0.2 grams of lead per gallon probably will not cause excessive engine wear. A complete elimination of lead from gasoline could cause excessive wear in gasoline-powered engines and require engine repair more often.

REGULATING UNDERGROUND TANKS

by

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Safety, health, and environmental concerns have been raised about leaking underground fuel tanks. Leaks can cause fires and explosions, and can contaminate soils, surface water, and groundwater. There is no inventory of the number of underground tanks, much less the number of those that have leaks. However, various estimates place the number of underground tanks at about 2 million, and up to 25 percent of them may be leaking (Westat, Inc., Rockville, Md., EPA Contract No. 68-01-6721). This is a serious concern because groundwater is a primary source of drinking water for about half the U.S. population.

The Environmental Protection Agency (EPA) has Federal regulatory authority in this area. To determine the extent of the problem, EPA is surveying farm and nonfarm businesses to estimate the number of underground tanks, the percent that are leaking, and the reasons why tanks leak. Following the survey, attention will focus on what can be done to detect and prevent leaks. In the initial screening, EPA surveyed 600 farms in selected geographic areas and found 30, or 5 percent, that had underground tanks. In the second phase of the study, these tanks will be tested to determine if they are leaking and, if so, why. The low percentage of surveyed farms having underground tanks may not be representative of the whole agricultural community because of the screening areas selected and the fact that decisions to bury fuel tanks depend heavily on local and State ordinances, soil type, and climate.

Congress has responded to concerns over leaking tanks by passing a law to regulate

underground tanks used to store petroleum and other hazardous substances (P.L. 98-616). The law exempts farm and residential motor fuel tanks of 1,100 gallons or less, but includes tanks of all sizes at other facilities, such as refineries and retail service stations. Heating oil tanks that store fuel for use on the premises also are exempt. However, the law requires the EPA to study heating oil tanks and small tanks on farms and residential property and to recommend whether these tanks should be regulated.

The law specifies that owners of underground tanks must notify designated State or local agencies concerning the existence of an underground tank, its age, size, type, location, and use. The law also prohibits the installation of new tanks that are not protected against corrosion, and requires the development of technical standards for new and existing tanks, including requirements for corrective action.

The notification requirement applies to tanks now in use or those that have been in use at any time since January 1, 1974. Proposed regulations concerning the notification requirement have been published in the Federal Register for comment (50:21771).

By February 1987, EPA plans to issue regulations for leak detection, prevention, and closure of tanks as well as issue design, construction, installation, leak detection, and material composition standards for new tanks. Because it will take several years for the new regulatory program to be put in place, the law imposes an interim standard for new underground storage tanks installed in most soil types. The law prohibits the installation of new underground tanks after May 7, 1985,

> "unless such tank ... -- (A) will prevent releases due to corrosion or structural failure for the operational life of the tank; (B) is cathodically protected against corrosion, constructed of noncorrosive material, steel clad with a noncorrosive material, or designed in a manner to prevent the release or threatened release of any stored substance; and (C) the material used in the construction or lining of the tank is compatible with the substance to be stored."

The law provides civil penalties to enforce its provisions. Fines of up to $25,000 can be levied for noncompliance.

The concern over leaking underground tanks has several implications for farmers. New tanks should not be installed unless they meet leak prevention and design guidelines, and old tanks should be monitored for product losses that indicate a leak. New State and Federal rules that will take effect over the next few years may have financial and legal implications for underground tank owners. As proposed Federal rules are published in the Federal Register, farmers and their farm organizations may want to comment on them to ensure the adoption of a cost-effective and environmentally responsible underground tank regulatory program.

ENERGY AND IRRIGATION

by
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Abstract: Land irrigated with on-farm pumped water increased 9.5 million acres, to 44.6 million, from 1974 to 1983. Sharply higher energy prices and more irrigated acres increased pumping expenditures during the same period from $551 million to $2.5 billion. Groundwater was the major source of increased on-farm pumped water, accounting for nearly 80 percent of the water applied to newly irrigated acreage. The future trend in groundwater irrigation will be dictated by such factors as energy prices, commodity prices, and the availability and adoption of new irrigation technology. While the near-term outlook for irrigation development is not optimistic, favorable economic conditions could lead to 3 to 4 million additional pump-irrigated acres in the water-short Great Plains by the year 2020 and significant increases in the more humid Eastern United States.

Keywords: Groundwater, energy, irrigation, pumping costs.

Vast amounts of energy are needed to pump water onto irrigated U.S. cropland, and energy needs are increasing as pump irrigation grows. The importance of irrigation to U.S. agriculture focuses attention on energy quantities, prices, and expenditures.

Total irrigation energy expenditures depend on a number of factors, including acres irrigated, energy prices, type of energy, and per-acre use. These factors are in turn affected by climate, crop mix, irrigation system, water availability, and current irrigation technology. This article examines these factors from a national and regional historical perspective, with the goal of assessing the outlook for irrigation and energy use.

Data used in this article come from an irrigation pumping energy survey (5) and the Census of Agriculture (9). The Census reports actual irrigated acreage and the value of irrigated production in the Census year, whatever the water source. The irrigation pumping survey provides energy use data for farm-pumped water. Water supplied from off-farm sources is excluded. The base acres included in the survey are those that are normally irrigated. Since the intent of this article is to analyze trends in energy use for irrigation pumping, only limited reference is made to Census data.

U.S. irrigated crop acres have increased from 7.5 million in 1900 to 49 million in 1982. These acres now account for 15 percent of our harvested cropland (table 7), although all land irrigated declined by over 1 million acres between 1978 and 1982. Nationally, sales from irrigated farms total nearly a third of the value of all farm products sold (table 8).

Regionally, irrigation plays an even more significant role. Much of the cropland in the Western United States would not be under cultivation without irrigation. In California, which ranks first in value of farm products sold, irrigated farms produce about 98 percent of total crops sold (9).

Approximately 84 percent of U.S. irrigated acres are located in the 17 arid and semi-arid Western States, where irrigation has been gradually expanding since 1978 (figure 38). However, the arid Southwest has lost

Table 7--U.S. irrigation trends

Year	Cropland harvested 1/	All land irrigated	Share irrigated
	Million acres		Percent
1900	415 2/	7.5	2
1930	359	19.5	5
1950	344	27.9	8
1978	320	50.3	16
1982	326	49.0	15

1/ Includes cropland harvested for field crops, vegetables, fruits, nuts, and other specialty crops. 2/ Improved cropland--harvested cropland not reported.

Source: (5).

Table 8--Value of U.S. agricultural products sold

Year	All farms	Irrigated farms 1/	Share of sales
	Million dollars		Percent
1900	2,910	87	3
1930	8,079	900	11
1950	22,052	na	na
1978	107,073	31,066	29
1982	131,900	39,714	30

na = not available.

1/ Includes production from nonirrigated acres on irrigated farms.

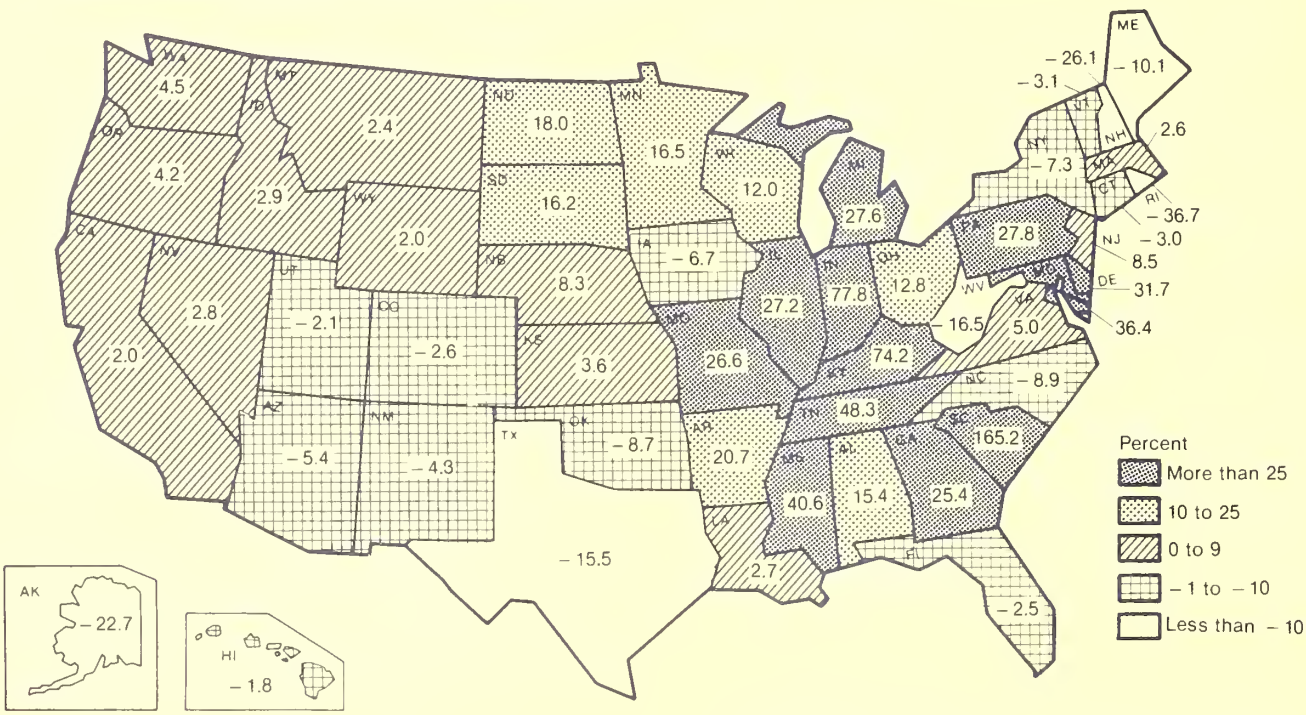
Source: (5).

irrigated cropland in those States experiencing declining groundwater levels.

In parts of the humid Eastern States, supplemental irrigation has been increasing rapidly as farmers attempt to raise returns per acre and reduce weather risks. Supplemental irrigation has climbed in the Lake States, most of the Corn Belt, and especially the Southeast, except in Florida, where wet weather in 1982 caused reduced irrigation of vegetables and sugarcane. Rainfall in the East is usually sufficient for crops, but periodic shortages during critical growth stages can lower production, and infrequent severe droughts,

Figure 38

Percent Change in Irrigated Cropland Acreage, 1978-1982



Actual Change in Irrigated Cropland Acreage, 1978-1982

AL	8,488	HI	-1,361	MA	424	NM	-31,675	SD	50,855
AK	-196	ID	86,640	MI	61,381	NY	-3,987	TN	5,337
AZ	-59,975	IL	34,906	MN	44,262	NC	-7,808	TX	-1,046,571
AR	345,811	IN	57,422	MS	123,966	ND	24,507	UT	-17,387
CA	150,022	IA	-6,506	MO	84,061	OH	3,095	VT	-51
CO	-69,893	KS	92,130	MT	36,086	OK	-44,441	VA	2,028
CT	-204	KY	9,158	NE	457,249	OR	55,997	WA	64,358
DE	10,585	LA	18,134	NV	16,596	PA	3,844	WV	-170
FL	-33,410	ME	-654	NH	-449	RI	-970	WI	27,591
GA	114,947	MD	10,196	NJ	6,390	SC	50,298	WY	22,133
								US	753,189

like the one in 1983, can be catastrophic. Supplemental irrigation in the East is expected to increase for that reason (7).

Payment-in-Kind

The USDA Payment-in-Kind program (PIK) in 1983 encouraged farmers to reduce their acreage of wheat, cotton, rice, and feed grains. As a result, about 12 percent of the 44.6 million acres of pump-irrigated land in the United States was held out of production that year (table 9). More than half of all pump-irrigated land withheld was located in the Northern Plains, primarily in Nebraska. Ignoring the normally irrigated acres set aside by PIK would have introduced a distortion in the 1974 to 1983 time series (5). Consequently, irrigation specialists were asked to estimate how much land would have been irrigated in 1983 without the PIK program. Data reported here reflect what pump irrigation and energy use would have been without PIK.

Irrigation Expansion

Pump-irrigated acreage in the United States increased over 27 percent from 1974 to 1983, groundwater being the major source (table 10). Growth in surface water use is limited by availability of impoundment sites and a general unwillingness to make large public expenditures for development.

Pump irrigation grew much faster in the Corn Belt and Lake States than in other regions of the country, mainly during 1974-80. However, pump irrigation in the Delta States grew more rapidly between 1980 and 1983, because of significant groundwater development in Arkansas for rice and double-cropped wheat and soybeans (table 11).

Of all the regions, the Northern Plains and Southeast regions experienced the largest absolute growth in irrigated acreage, growth which also took place during 1974-80. The Southern Plains had a slight decline in pump-irrigated land from 1974 to 1983. The principal area of decline was in the Texas High Plains, where the Ogallala Aquifer is being depleted. The annual rate of decline in the Southern Plains was twice as fast in 1980-1983 as in 1974-1980. Agricultural commodity prices, irrigation costs, and the adoption of more efficient technology affected the regional growth rates of irrigated acreage and will influence future irrigation development.

Table 9--Estimated pump-irrigated acres withheld from production for the Payment-in-Kind Program, 1983

Region	Acres withheld
	Thousand
Northeast	0
Lake States	196
Corn Belt	95
Northern Plains	2,860
Appalachia	0
Southeast	45
Delta States	140
Southern Plains	330
Mountain	956
Pacific	824
Alaska and Hawaii	0
Total	5,446

Source: (5).

Table 10--Acreage irrigated with on-farm pumped water

Water source	1974	1977	1980	1983	Acreage change 74-83	Change 74-83
	Million acres					Percent
Groundwater	25.6	30.0	31.6	33.1	7.5	29
Surface water	7.3	8.0	7.9	8.2	.9	12
Both sources	2.2	2.3	3.1	3.3	1.1	50
Total	35.1	40.3	42.6	44.6	9.5	27

Source: (5).

Energy Use in Irrigation: Regional Growth Patterns

Electricity, diesel, gasoline, natural gas, and liquified petroleum gas (LP gas) are used for pumping irrigation water. Minor changes have been made in the procedure for

Table 11--Regional changes in acreage irrigated with on-farm pumped water

Region	1974	1983	Change from 1974-1983		Average annual change	
					74-80	80-83
	Thousand acres		Thousand acres	Percent	Percent	
Northeast	292	329	37	13	1.4	1.2
Lake States	411	1,269	858	209	30.2	3.3
Corn Belt	370	990	620	168	26.0	2.3
Northern Plains	7,250	11,594	4,344	60	8.7	1.7
Appalachia	192	344	152	79	8.6	6.1
Southeast	2,041	3,858	1,817	89	11.7	3.6
Delta States	2,688	3,760	1,072	40	2.2	8.0
Southern Plains	9,517	8,523	-994	-10	-.9	-1.8
Mountain	6,020	6,574	554	9	1.4	.1
Pacific	6,286	7,334	1,048	17	1.8	1.8
Alaska	7	2	-5	71	-25.0	0
Hawaii	73	85	12	13	-2.7	0
Total	35,147	44,662	9,515	27	3.7	1.4

Source: (5).

calculating energy requirements to account for the adoption of low-pressure sprinkler irrigation systems. In addition, in estimating energy requirements in 1974, 1977, and 1980, adjustments were made for electrical pumping. All estimates in this report reflect those changes and thus may differ slightly from estimates reported previously (7).

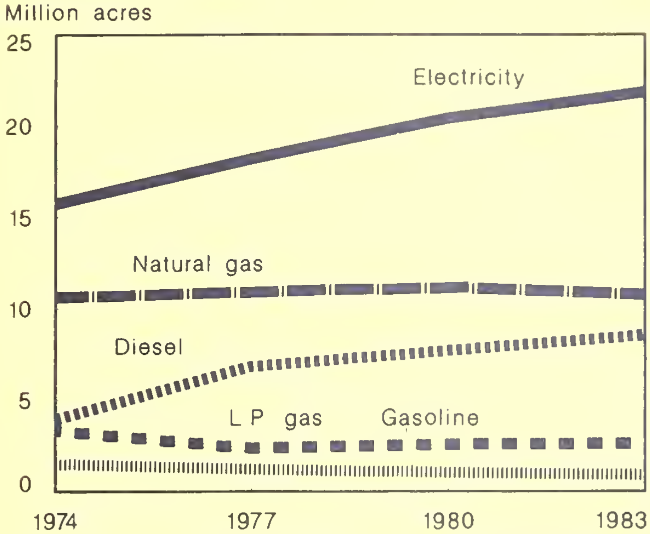
The energy source most widely used is electricity, with nearly 22 million acres irrigated in 1983, up from 15 million in 1974 (figure 39). The Mountain and Pacific regions accounted for more than half of all acreage irrigated with electricity in 1983 (appendix table 1). Annual rates of electricity use for irrigation pumping in the United States increased 5 percent between 1974 and 1980, twice the 2.3-percent rate in 1980-83 (table 12). Between 1974 and 1980, rates of growth in electricity use were highest in the Corn Belt (49.3 percent) and Delta States (35.3 percent), but dropped 11.7 percent in Appalachia, where North Carolina accounted for most of the change. During 1980-83, acreage irrigated using electricity increased most in the Delta States, Lake States, and Northeast, continued to decline in Appalachia, and slipped in the Southern Plains as well (appendix table 1).

Where available, natural gas is also used widely; in 1983 about 11 million acres were irrigated using natural gas-powered pumps, mainly in the petroleum-producing Plains and Mountain regions. This is essentially the same use reported in 1974. There was an 8-percent annual growth rate in natural gas use in the Northern Plains from 1974 to 1980. During the same period there was a decrease in Southern Plains use, but that may have been due primarily to the overall decline in irrigated acres and the increase in natural gas prices.

Irrigators using diesel fuel for pumping have more than doubled their acreage--from 3.9 million in 1974 to about 8.6 million in 1983. The use of diesel fuel is concentrated in the Northern Plains, Southeast, and Delta States, where electricity and natural gas prices are higher and/or installation costs substantial. The annual growth rate in acreage using diesel fuel for irrigation

Figure 39

Acreage Irrigated With On-Farm Pumped Water



pumping was more than three times the rate of electricity growth from 1974 to 1980, and 1.6 times faster from 1980 to 1983.

Gasoline and LP gas were used to pump irrigation water on only 3.5 million acres in 1983, down from 4.8 million in 1974. The rate of decline in use ran from 4 to 5 percent a year until 1980, when LP gas use began to increase slightly. These two energy sources are used in localized situations where smaller, more mobile irrigation systems are used, and other, cheaper alternative fuels are unavailable.

Per-Acre and Total Energy Use

Energy use per acre for on-farm irrigation pumping depends on three factors: (1) distance the water must be lifted from its source to the field, (2) the type of application system used, and (3) the quantity of water applied.

Pumping lifts for surface water are usually shorter than for ground- water, so energy used per acre is less. The exception is the Pacific Northwest, where river water is often pumped to high plateaus. Groundwater pumping lifts vary significantly among the States and regions. In much of the Great Plains, from Southwest Nebraska through the High Plains of Texas, 200- to 300-foot lifts are common. In some parts of California and Arizona, 500- to 600-foot pumping lifts are not unusual. Hawaii has very high (700 feet) lifts, as does the Mountain region, thus requiring large energy use per acre.

Water pressure requirements for irrigation distribution systems range from 25 to 30 pounds per square inch (psi) to over 100 psi. Systems that allow water to flow by gravity have pressure requirements of 0 to 10

Table 12--Annual change in acreage irrigated with on-farm pumped water

Region	Electricity		Diesel		Gasoline		Natural gas		LP gas		Total	
	74-80	80-83	74-80	80-83	74-80	80-83	74-80	80-83	74-80	80-83	74-80	80-83
	Percent											
Northeast	-3.2	13.3	9.6	12.5	-4.1	0.5	na	na	-4.6	0	1.4	1.2
Lake States	17.0	6.2	70.6	0.6	60.2	2.5	na	na	27.3	-12.6	30.2	3.3
Corn Belt	49.5	3.4	78.7	2.4	-8.0	-2.8	83.3	-5.6	7.7	2.1	26.0	2.3
Northern Plains	18.0	3.3	13.5	0.6	-8.0	0.8	8.0	1.4	-2.8	3.7	8.7	1.7
Appalachia	-11.7	-7.8	88.6	10.3	13.7	4.4	na	16.7	16.7	5.6	8.6	6.1
Southeast	10.7	5.5	14.7	6.0	1.9	-2.2	na	0	8.6	-11.3	11.7	3.6
Delta States	35.3	9.5	14.3	8.4	-14.0	-23.3	-7.2	-2.1	-15.4	26.4	2.2	8.0
Southern Plains	0.4	-1.6	1.6	-1.2	-0.8	-2.9	-1.3	-2.0	-0.5	-1.3	-0.9	-1.8
Mountain	1.9	0.6	1.4	4.7	10.1	-18.1	-1.0	-0.4	1.3	-2.5	1.4	0.1
Pacific	1.5	1.8	541.7	-1.0	0	0	0	0	0	0	1.8	1.8
Alaska and Hawaii	2.7	0	na	na	0	0	0	0	0	0	2.2	0
Total	5.0	2.3	15.8	3.8	-5.2	-4.5	0.8	-1.2	-3.9	0.5	3.7	1.4

na--not available.

Source (5).

psi. Regions with a high percentage of sprinkler irrigation systems--Northeast, Lake States, Southeast, Corn Belt--use more energy per unit of water applied than regions with a lower concentration of sprinkler systems.

The desert areas of Arizona, California, and Nevada and the dry plains of the Pacific Northwest require more water per acre and hence greater amounts of energy for irrigation than does acreage in the more humid East. In desert areas, water application rates can reach 6 acre feet (an acre foot is 1 foot of water applied over 1 acre), while Great Plains rates seldom exceed 2 acre feet. In more humid Eastern areas, applications are often 1 acre foot or less (5).

Per-acre energy use for almost all types of fuel rose between 1974 and 1983. Electricity use increased 4 percent, rising from 1,013 kilowatt hours (kwh) per acre to 1,055 (table 13). Diesel, gasoline, and LP gas use per acre increased by more than 30 percent over the same period, while natural gas use remained nearly constant.

Per-acre energy use increased for three reasons:

- Seventy-nine percent of the increase in irrigated area relied upon groundwater rather than surface water supplies, i.e., 7.5 million of the 9.5-million-acre increase was in groundwater irrigation. It is likely that groundwater also made up a significant share of the 1.1 million acres irrigated with both sources.

- Groundwater levels are declining in some areas of the Plains and Mountain regions, making the lifts greater.

- Of the newly irrigated land, 86 percent utilized sprinkler systems, rather than gravity-flow systems. A significant share of this new acreage relied on diesel fuel for pumping.

Total energy use for on-farm pumped irrigation increased for all fuel sources except gasoline (table 13). The largest increase was in diesel, which nearly tripled from 1974 to 1983. Diesel use increased 22 percent a year from 1974 to 1980, but the rate of increase dropped to 8 percent annually thereafter. Growth in diesel use was concentrated in the Northern Plains, Lake States, Southeast, and Delta States (5). Electricity use expanded by over 40 percent in the same regions, primarily for groundwater pumping. Nationally, however, electricity use grew by only 5 percent a year in the early period and gains slowed further to about 3 percent annually from 1980 to 1983.

Energy Prices and Irrigation Costs

On-farm energy expenditures for pumping irrigation water increased from $551 million in

Table 13--Total and per-acre energy use for on-farm pumped irrigation water

Fuel type	Unit	1974	1977	1980	1983	Annual average change 74-80	Annual average change 80-83
						Percent	
Total use:							
Electricity	Mil kwh	16	19	21	23	5.0	3.0
Diesel	Mil gal	184	360	429	530	22.0	8.0
Gasoline	Mil gal	67	72	61	57	-2.0	-2.0
Natural gas	Mil MCF	129	143	146	144	2.0	-.5
LP gas	Mil gal	238	234	254	257	1.0	.4
Per-acre use:							
Electricity	Kwh	1,013	1,044	1,029	1,055	.3	.8
Diesel	Gal	47	53	56	62	3.0	4.0
Gasoline	Gal	45	60	61	63	6.0	1.0
Natural gas	MCF	12	13	13	13	1.0	0
LP gas	Gal	72	98	98	99	6.0	.3

Source: (5).

1974 to more than $2.5 billion in 1983 (appendix table 2). The 352-percent rise was due to higher energy prices and increased energy use (5). The average cost of energy used climbed from $16 per acre in 1974 to $56 in 1983 (5). During the earlier part of this period, higher commodity prices helped offset rising energy prices. However, over the last 3 years of the period, commodity prices stagnated. Unfavorable commodity prices partly account for the slower increase in irrigated acreage--from 3.7 percent annually during 1974-1980 to 1.4 percent between 1980 and 1983.

National average prices for electricity, diesel, gasoline, natural gas, and LP gas have increased sharply since 1974 (table 14). Diesel, natural gas, and LP gas prices do not vary regionally, but significant regional differences are found in the price of electricity. The Pacific Northwest, with a large hydroelectric capacity, supplies power at 1 to 2 cents per kwh, one-third to one-fourth of what irrigators pay in other areas (5).

Natural gas has been the cheapest fuel for internal-combustion engines, and it is used extensively for pumping irrigation water in the Great Plains and Mountain regions. Irrigators close to natural gas distribution systems in these areas enjoy a cost advantage over users of diesel, gasoline, LP gas, and electricity. However, recent increases in energy prices are changing the price relationships (figure 40). From 1974 to 1980, electricity and LP gas prices rose annually by 17 and 18 percent, while gasoline, natural gas, and diesel increased 25 percent or more. Significantly, between 1980 and 1983 diesel prices actually declined while all other energy sources, except natural gas, increased 3 to 8 percent annually. Natural gas prices rose by 20 percent a year.

Regional energy price trends indicate that since 1980 diesel has begun to have an advantage over most other energy sources (table 15). This is seen particularly in the Northern Plains, Delta States, and Southeast, where diesel rivals electricity as a source of pumping power. In these areas diesel prices have declined by 1 percent or more annually since 1980.

Natural gas price increases brought about by deregulation are making electricity and diesel more competitive. Natural gas is still cheaper than electricity in some areas, but the gap is narrowing rapidly. Gasoline has consistently been more expensive than diesel fuel and is used less because of this disadvantage.

Electricity expenditures accounted for about 46 percent of all energy costs incurred for irrigation in 1983, while diesel and natural gas costs contributed another 22 percent each. Total expenditures for diesel fuel and natural gas increased rapidly between 1974 and 1983, indicating the natural gas price rise and adoption of diesel-powered pumps (5).

Table 14--Selected U.S. farm energy prices

Item	Unit	1974	1977	1980	1983	Average annual change 74-80	Average annual change 80-83
		Dollars per unit				Percent	
Electricity	Kwh	.027	.035	.055	.065	17	6
Diesel	Gal	.37	.45	1.00	.99	28	-.3
Gasoline	Gal	.47	.57	1.15	1.18	24	1
Natural gas 1/	MCF	1.00	1.50	2.50	4.00	25	20
LP gas	Gal	.30	.39	.62	.77	18	8

1/ Estimated by State irrigation specialists.

Sources: (1, 5, 9).

Figure 40

Annual Change in Energy Prices

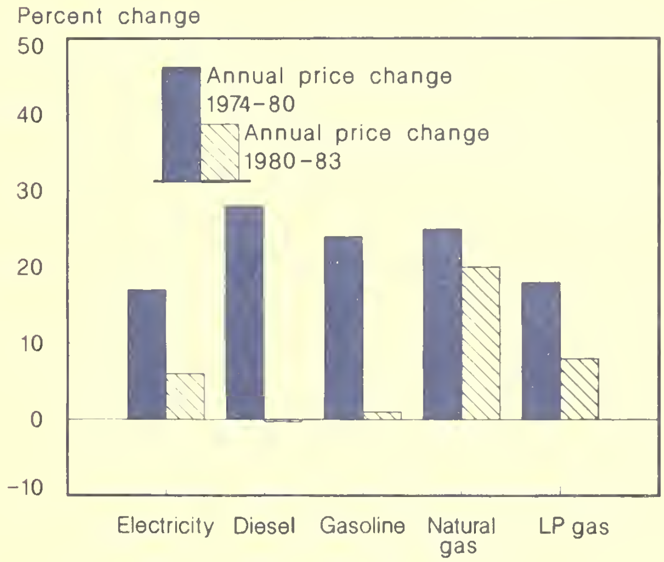


Table 15--Annual percentage change in energy prices for on-farm pumped irrigation water

	Electricity		Diesel		Gasoline		Natural gas		LP gas	
Region	74-80	80-83	74-80	80-83	74-80	80-83	74-80	80-83	74-80	80-83
	Percent									
Northeast	24.0	11.5	28.6	1.9	23.0	.8	na	na	18.5	12.7
Lake States	30.4	3.1	30.6	-.3	23.5	.3	na	na	16.1	10.9
Corn Belt	20.3	8.5	28.2	1.0	24.7	1.4	25.0*	18.7	16.7	7.2
Northern Plains	25.0	9.3	31.9	-1.0	23.8	2.2	25.0*	15.7	17.3	7.3
Appalachia	18.1	9.7	28.5	1.0	22.8	.9	25.0	33.3	14.8	8.1
Southeast	23.9	8.3	31.5	-1.6	24.3	1.2	na	na	19.1	7.6
Delta States	17.4	17.0	28.7	-1.0	25.4	.3	36.7*	.9	15.6	11.8
Southern Plains	15.9	14.8	32.8	-1.3	27.9	-.6	25.0*	13.3	19.0	7.5
Mountain	20.2	5.6	28.8	-1.0	24.8	1.4	25.0*	21.1	20.1	5.2
Pacific	29.4	2.8	27.0	0	na	na	56.2*	11.7	na	na
Alaska and Hawaii	25.0	0	na	na	na	na	na	na	na	na

na = not applicable. *National average price of $1.00 was used in 1974.

Expenditures for electricity increased from $288 million to $1.2 billion during the study period.

Pump irrigation energy expenditures in the major producing regions of the Lake States, Southeast, and Corn Belt grew much faster than in other regions from 1974 to 1983, but Delta States costs rose faster between 1980 and 1983 than during 1974-80 (appendix table 2). In each case, acreage increases account for most of the expenditure rise.

Outlook for Irrigation and Energy Use

Water availability will partly dictate the rate of growth or decline in irrigated land. Groundwater levels are falling beneath 15 million acres of irrigated land in 11 major groundwater States, but only Arizona, Colorado, New Mexico, Oklahoma, and Texas experienced significant irrigated cropland reductions between 1978 and 1982 (3, 9). Over half of the water in the Ogallala Aquifer may be depleted by the year 2020. Of the States served by this water source, only Nebraska is not likely to experience reduced irrigated acreage (2). In addition, many areas will experience groundwater mining as the acreage irrigated continues to expand. Furthermore, little future development of surface water supplies for irrigation is expected in the West.

While pump irrigation will eventually decrease in regions with declining groundwater, favorable ratios between commodity prices and energy costs would likely cause pump irrigation to increase where adequate water supplies and proper soil and climate exist. An interagency task force in 1979 identified 26 million acres in the Eastern United States as potentially irrigable (4). Although that potential may not be fully realized, pump irrigation increased by 4.5 million acres in the Eastern farming regions from 1974 to 1983 (table 11). Considerable expansion of pump irrigation is possible in the Eastern half of the United States, given favorable economic conditions (5).

Relative advantages of the five major fuels are less certain. Continued deregulation of natural gas prices may further stimulate the shift to electricity and diesel fuel. Electricity prices recently have been rising faster than diesel prices. This trend could continue, as nuclear power generation costs become incorporated into electricity rate

structures. Although diesel is becoming more competitive with electricity, how competitive it will be over time is unclear.

An estimated 24 percent of all center-pivot irrigation sprinklers used in 1983 were low-pressure systems. Irrigators have been adopting low-pressure center-pivot technology to cut energy use and production costs. The trend toward low-pressure systems appears to be continuing (5). Besides the new center pivots that can be installed as low-pressure systems, some standard systems that take 100 psi can be converted to low-pressure systems (35 psi), saving substantial energy (5). However, not all center-pivot systems can be converted to low pressure. Because of the high rates of water applied, low-pressure center-pivot systems require soils with high water intake rates and gentle slopes to prevent runoff.

To cut energy use, irrigation organizations and farmers are improving distribution efficiency by lining canals and ditches or installing pipelines in place of ditches. However, application efficiency appears to be the most promising improvement. Techniques that have been widely adopted to reduce water application rates include tail-water recovery systems, scheduling of water applications, and drip irrigation on perennial crops (7). Limited use has been made of laser leveling of fields, automated gravity-flow systems, and drip irrigation for annual field crops. Measures that cut water use also reduce energy requirements.

Moreover, research is in progress to reduce plant water requirements. If plant varieties can be developed that maintain or improve yields while using less water, then use efficiency can be improved and further energy savings are possible (7).

The future for U.S. cropland irrigation depends largely on the relative levels of energy and commodity prices and the rate at which more efficient irrigation technologies are adopted. If commodity prices do not rise faster than energy prices, or gains in irrigation efficiency do not continue, irrigated acreage is unlikely to expand much above present levels. Even if measures are adopted to conserve water and energy, rising energy prices and declining groundwater levels set the stage for larger total energy expenditures for on-farm irrigation pumping.

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PESTICIDES

Demand

Total 1985 farm pesticide use on major field crops is projected at 505 million pounds, active ingredients (a.i.), based on plantings of 281.4 million acres (table 16). Herbicides will account for 85 percent of total pesticide use. Of the 432 million pounds (a.i.) of herbicides, 83 percent will be used in corn and soybean production. The corn crop is expected to account for 47 percent of 1985 insecticide use. However, insecticides are being used more intensively on cotton, with 16 million pounds (a.i.) applied to 11 million acres. In 1984, farmers reported treating 42 percent of the corn and 63 percent of the cotton acreage with insecticides. Fungicide use is projected at 7.1 million pounds (a.i.) with 77 percent used in peanut production.

Prices

Farm-level herbicide prices were down 4.4 percent in May from a year earlier, after dropping 5.9 percent between 1983 and 1984 (table 17). Butylate prices declined 7.8 percent, followed by atrazine at 7.7 percent,

Table 16--Estimated pesticide use by U.S. field crop farmers

Crop	June 1, 1985 planted acreage	Projected 1985 use: Herbicides	Insecticides	Fungicides
	Million	Million pounds (active ingredients)		
Row:				
Corn	83.2	248	30.6	.07
Cotton	10.8	16	16.0	.17
Grain sorghum	17.3	16	2.7	0
Peanuts	1.5	6	1.2	5.50
Soybeans	63.3	111	9.7	.06
Tobacco	.7	1	2.7	.36
Total	176.8	398	62.9	6.16
Small grains:				
Barley and oats	26.3	7	.2	0
Rice	2.5	11	.4	.06
Wheat	75.8	16	2.1	.87
Total	104.6	34	2.7	.93
Total	281.4	432	65.6	7.09

Table 17--U.S. average farm retail pesticide prices 1/

Pesticide	1983	1984	1985	Change 84-85
	Dollars per pound 2/			Percent
Herbicides:				
Alachlor	5.00	5.25	5.25	0.0
Atrazine	2.50	2.22	2.05	-7.7
Butylate+	3.37	3.46	3.19	-7.8
Cyanazine	--	4.48	4.63	3.3
Metolachlor	--	6.24	6.14	-1.6
Trifluralin	7.70	6.90	6.45	-6.5
2,4-D	2.64	2.42	2.37	-2.1
Composite 3/	4.58	4.31	4.12	-4.4
Insecticides:				
Carbaryl	3.65	3.75	3.81	1.6
Carbofuran	10.24	10.55	10.44	-1.0
Chlorpyrifos	--	8.33	8.25	-1.0
Fonofos	--	8.79	8.94	1.7
Methyl parathion	2.66	2.90	2.91	0.3
Phorate	--	6.26	6.65	6.2
Synthetic pyrethroids	58.40	56.00	53.20	-5.0
Terbufos	--	9.55	9.91	3.8
Composite 3/	9.88	10.04	9.97	-0.7

1/ Based on a May survey of farm supply dealers conducted by the Statistical Reporting Service, USDA. 2/ Active ingredient. 3/ Includes above materials and other major materials not listed.

-- = not reported.

and trifluralin at 6.5 percent. The price of cyanazine increased 3.3 percent while alachlor's price remained unchanged from May 1984. The May 1985 composite herbicide price of $4.12 rose from March's $4.02 because of a seasonal increase in demand.

Farm-level insecticide prices were down 0.7 percent in May from a year earlier. Synthetic pyrethroid prices declined 5 percent because of increased competition from second-generation pyrethroid products. The price of phorate increased the most (6.2 percent), followed by terbufos at 3.8 percent. However, prices for two other major corn insecticides, carbofuran and chlorpyrifos, declined 1 percent.

Regulatory Actions

On March 27, 1985, the Environmental Protection Agency (EPA) published in the Federal Register (50:12188) the proposed criteria and procedures for its new Special Review (SR) process. The SR process will

replace the Rebuttable Presumption Against Registration (RPAR) process as EPA's approach to analyzing the risks and benefits of pesticides suspected of being unreasonably hazardous to man or the environment. One EPA goal is to target Agency time and resources to those pesticides posing the greatest risks. A second major goal is to expedite the review process when a Special Review is necessary.

Resource Utilization

EPA has proposed a new set of pesticide risk criteria which will consider both toxicity and exposure data in deciding whether to initiate an in-depth review. Under the current criteria, EPA has been required to begin an RPAR whenever laboratory tests indicate a pesticide meets or exceeds a set of rigid numerical acute toxicity criteria or shows a chronic toxic effect in a laboratory setting. The Agency has not been allowed to consider the toxicity results in light of a realistic environmental setting; an RPAR had to be initiated even when the EPA suspected that exposure was negligible. By considering exposure at an earlier stage, EPA believes it may be able to avoid extensive reviews on pesticide uses where the lack of exposure may mean that a toxic product is not posing an unreasonable risk.

Also, under the SR process, the Agency will focus risk/benefit analyses only on those use patterns of the pesticide that may be presenting unreasonable risks. This will reduce the number of analyses and allow other uses to continue through normal registration channels.

Expediting the Review Process

Under the SR format, more data are to be gathered prior to formally initiating a review than under the RPAR framework. Pre-review analyses will include a review of the adequacy of existing exposure data, identification of the uses to be considered in the review, and a brief analysis of the product's current benefits. The Agency also plans to identify the chemical and nonchemical alternatives to the pesticide uses under review. Critical data can be required of registrants through the registration standard/data call-in program or through other Agency authority to exact data (i.e. FIFRA section 3(c)(2)(B) notices). The Agency also has surrogate data which may fill in important data gaps. With this background information and with data gaps identified and resolved, EPA can be better prepared to conduct a speedy and thorough review. Further, EPA plans to make regulatory decisions on specific product uses as the appropriate data become available, instead of postponing a regulatory decision on a pesticide use until data on all uses are assimilated.

The SR format can also expedite a pesticide review by allowing for voluntary or simple risk mitigation measures. The early Special Review work includes open EPA interaction with the pesticide registrant (as well as any other interested parties). If the registrant chooses to adopt voluntary measures that adequately reduce the presumed risk associated with a pesticide use, the review can be terminated and no extensive risk/benefit analyses would be required. Similarly, if EPA determined that a relatively minor action such as a protective clothing requirement would effectively reduce a product's risks, the action could be taken without extensive risk and benefit analyses. In either case, a Federal Register notice would allow for public comment on the Agency's determination, and public meetings may be held prior to the Agency's proposed decision.

Status Report

EPA has already begun calling its investigations "Special Reviews," although RPAR procedures will be followed until the Special Review format is formally adopted. The public is informed of the initiation of a Special Review with the publication of a Position Document (PD) 1. EPA presents its proposed regulatory decision on a pesticide in a PD 2/3, and a final position document (PD 4) delineates EPA's actual regulatory decision.

Eighteen pesticides were listed in the February 1985 Inputs report (IOS-7) as in the process of or candidates for EPA Special Review. The status of those pesticide reviews follows:

Expected completion of PD 1's:

Acephate -- Not yet under Special Review classification; additional data are being requested from the registrant.

Captafol -- PD 1 issued in January 1985. Analysis of public rebuttal submissions is underway.

Triphenyltin Hydroxide -- PD 1 issued in January 1985. EPA is responding to rebuttal comments and awaiting results from a teratology study.
Chlordimeform -- In the Registration Standards process but not officially under Special Review.
Cyanazine -- PD 1 issued in April 1985.

Expected completion of PD 2/3's:
Cadmium -- EPA is responding to PD 1 rebuttals; risk assessment is underway.
Linuron -- PD 1 issued in September 1984. Risk assessment is ongoing. Completion of the PD 2/3 will be delayed until additional data on dietary exposure are received from the registrant.
Amitrole -- EPA has been responding to PD 1 comments. Dermal absorption study received from registrant in late April. Study results may initiate a revised risk assessment.
Carbon Tetrachloride -- Registrants have requested voluntary cancellation of all carbon tetrachloride registrations as a grain fumigant.
Captan -- PD 2/3 issued in June 1985.
Daminozide -- PD 2/3 expected to be issued in August 1985.
Aldicarb -- PD 1 issued July 1984. EPA is responding to rebuttal comments, especially in the areas of groundwater and environmental fate.
Inorganic Arsenicals (Non-wood uses) -- Risk assessment underway.
Alachlor -- PD 1 issued in December 1984. EPA is responding to rebuttal comments.

Expected completion of PD 4's:
Creosote (Non-wood uses) -- Completion of PD 2/3 being rescheduled pending receipt of additional material from the registrant.
Pentachlorophenol (Non-wood uses) -- PD 2/3 issued in November 1984. EPA is responding to PD 2/3 rebuttal comments.
Compound 1080 -- The PD 4 was signed on July 24, 1985. Use for rodent control was granted providing that registrants modify labels to include reduced dosage rates, baiting procedures, and a hazard warning concerning endangered species. In addition, the registrants must generate basic data, including toxicity, product and residue chemistry, and environmental fate, to support continued registration.

Registration of the 1080 toxic collar for predator control in sheep and goat production was addressed as a separate issue outside of the Special Review process. On July 18, EPA approved the Department of Interior's (USDI) registration applicaton for use of the toxic collar on private and Federal lands with several restrictions. The more important requirements include: use only by applicators who receive special training and certification; use in fenced areas, versus open range; bilingual warning signs placed at access points to the fenced areas; maintainance of written records on the purchase, use, and disposal of the toxic collars; and reporting deaths of non-target species. The USDI is to establish a monitoring program to determine the number of collars used, effectiveness in predator control, and impact on non-target species.
Dicofol -- EPA is reviewing PD 2/3 rebuttal data submitted by the producer. The thrust of the original risk assessment was based on dicofol's adverse ecological effects due to product contamination with DDTr. The Agency is now exploring the possibility that dicofol exposure causes tumors.

Preliminary indications are that the PD 4 will require the manufacturer to reduce the DDTr contamination to 2.5 percent by January 1986 and to 0.1 percent by July 1987 for continued registration. Label modification will include the avoidance of skin contact and the wearing of gloves when using dicofol products.

EPA has issued the following Special Review position documents in fiscal 1985:

Alachlor (PD 1) -- EPA has initiated a Special Review of herbicides containing the active ingredient (a.i.) alachlor. The Agency's major concern is that alachlor may be a human carcinogen. Workers involved in the application of alachlor receive the most exposure. The general population receives some dietary exposure from consumption of residues found in certain foods and drinking waters.

EPA's PD 1 reports that 90 to 95 million pounds (a.i.) of alachlor are used annually. Preemergent applications to

corn, soybeans, and peanuts are the predominant use, although alachlor is also used on sweet corn, popcorn, cotton, dry beans, grain sorghum, green peas, green lima beans, sunflowers, and ornamentals. The product's registrant has withdrawn the use of alachlor on potatoes; also, all aerial application has been discontinued.

During the Special Review, EPA is requiring that applicators use protective clothing and follow handling instructions to reduce exposure. Label warnings that a possible tumor hazard exists and to avoid water contamination also are being required.

Captafol (PD 1) -- EPA has determined that use of the fungicide captafol may exceed the risk criteria for oncogenicity (tumor-causing) and may be a hazard to wildlife. The general public is considered to be facing a possible risk of oncogenicity from dietary exposure to captafol residues. Captafol is also highly toxic to fish. Of particular concern are applications to cranberry bogs and citrus groves where fish populations may be exposed via aerial drift or runoff.

EPA estimates that 4.5 to 5 million pounds (a.i.) of captafol are used annually, primarily on apples, cherries, tomatoes, and citrus. Minor uses include potatoes, sweet corn, plums, watermelon, cranberries, and various seed treatments. The PD 1 indicates that all uses will remain registered during the Special Review. New registrations of products where captafol is the sole active ingredient will not be issued during the review. Pending and/or new residue tolerance requests also will be deferred until the review is completed.

Captan (PD 2/3) -- EPA proposes to cancel all food uses of the fungicide captan. The Agency believes that captan may be a human carcinogen. Populations considered at risk are workers due to dermal exposure and the general population through the consumption of foods bearing captan residues. EPA notes that the cancer risk from dietary exposure may be overestimated in the PD 2/3; the Agency used worst-case assumptions concerning captan residue levels in foods because it had no reliable data on actual residues. EPA is proposing to delay cancellation for 2 years while registrants generate information on actual residue levels.

Some 10 million pounds (a.i.) of captan are used annually in the United States, primarily on fruit and vegetable crops, including apples, almonds, stone fruits, and grapes. Captan is also found in many nonfood items such as wallpaper paste, oil-based paints, cosmetics, and pet shampoos. While EPA is not including nonfood uses in the proposed action, the Agency is recommending protective clothing requirements to reduce captan exposure.

Cyanazine (PD 1) -- Tests conducted on the herbicide cyanazine concluded that it caused teratogenic (birth defects) and fetotoxic (toxic to the fetus) effects in laboratory animals. Due to dermal exposure, applicators are considered the population at risk. Residues have not been found in crops, so dietary exposure to the general population is not a major concern.

Of the 21.4 million pounds (a.i.) of cyanazine used in the United States, 96 percent is on corn production. Other applications are to cotton, sorghum, and wheat. Registrations for all uses will be retained during the Special Review; however, cyanazine products have been classified as restricted use, and the manufacturer has been instructed to include a teratogen warning on product labels. Additional data on teratogenicity are due in December 1985, and data concerning possible contamination of drinking water are due in June 1986.

Pentachlorophenol (Non-wood uses) (PD 2/3) -- EPA has proposed a regulatory decision that cancels most non-wood uses of pentachlorophenol ("penta"). Exposure to penta has caused fetotoxic effects in laboratory animals, and two penta contaminants (dioxins and hexachlorobenzene) may pose a risk of oncogenicity. At risk are penta applicators from dermal exposure, primarily to the hands. There is also some potential dietary exposure to the general population from consumption of residues in a few products.

Non-wood uses account for roughly 20 percent of the penta used in the United States. Products containing penta range from herbicides to antimicrobial agents, disinfectants, mossicides, and defoliants. EPA has determined that, for most uses, efficacious and cost-effective alternatives are available on the market and that the economic impacts of losing these uses would be minimal. The Agency is proposing the continued but modified registration of penta as an antifungal agent in oil well flood waters and in pulp and paper mill solutions. A decision on penta use as a termiticide is pending.

Triphenyltin Hydroxide (PD 1) -- A Special Review is being initiated on the fungicide triphenyltin hydroxide (TPTH) based on studies where TPTH produced teratogenic effects in laboratory animals. In two separate studies, adverse effects were observed at all dosage levels, so a "no-observed-effect-level" has not been established. The population potentially at risk is applicators due to dermal exposure. To further investigate the effects of TPTH, EPA is requiring an additional teratology study, as well as submissions on possible oncogenic and other chronic toxic effects and data clarifying TPTH's environmental fate.

Over 72 percent of TPTH use is on pecans, primarily in the Southeast where environmental conditions are conducive to fungus development. Benomyl is an alternative to TPTH use on pecans, although the PD 1 expresses concern over the possible development of benomyl resistance in fungus strains. TPTH is also used on sugar beets, peanuts, carrots, and potatoes. Current registrations of TPTH products will be maintained during the Special Review, but decisions on new uses and tolerance petitions will be deferred until the review is concluded. EPA has classified TPTH products as restricted use and is requiring both a label warning that TPTH causes birth defects in laboratory animals and that users wear protective clothing.

Groundwater Survey

EPA's Offices of Pesticide Programs and Drinking Water are launching an extensive national survey of pesticides in groundwater. Approximately 1,400 wells will be included in the survey, and samples will be analyzed for some four dozen pesticides. Goals of the study are to identify the extent of groundwater contamination due to normal agricultural practices and to estimate human exposure to pesticides via contaminated drinking water. Another major goal is to identify the relationships between pesticide uses, field conditions, aquifer characteristics, and contamination. The survey is tentatively scheduled to begin in spring 1986; a final report is expected before the end of 1988.

FERTILIZER

Use

Fertilizer use in 1984/85 is projected to be near the 21.9 million tons of plant nutrients used a year earlier. Fertilizer consumption last fall was down because of wet weather and reduced winter wheat plantings. However, excellent spring planting weather and more corn acres contributed to increased fertilizer use.

Supplies

Domestic fertilizer supplies at the end of April 1985 were down from a year earlier but were adequate to meet 1984/85 crop needs. Supplies of nitrogen and potash were down 5 and 7 percent, respectively, as fewer imports and greater exports more than offset increased production (table 18). Increased phosphate exports offset larger production, lowering phosphate supplies about 11 percent.

Trade

Increased world fertilizer demand and stable or declining fertilizer prices in 1984/85 spurred U.S. fertilizer exports. The expansion in the export market translated into increased U.S. fertilizer production. Nitrogen exports from July 1984 to April 1985 increased 77 percent to 2.8 million tons, while phosphate exports advanced 46 percent to 4.9 million tons. Exports of diammonium phosphate accounted for about 44 percent of all nitrogen exports and 65 percent of phosphate exports. Anhydrous ammonia and urea accounted for another 47 percent of nitrogen exports. Exports of phosphoric acid and triple

Table 18--U.S. fertilizer supplies 1/

Item	1983/84	1984/85	Change
	Million short tons		Percent
July 1 Inventory:			
Nitrogen (N)	2.00	1.66	-17
Phosphate (P_2O_5) 2/	.66	.81	+23
Potash (K_2O)	.46	.31	-33
Production:			
Nitrogen	10.16	11.33	+12
Phosphate 2/	8.76	9.45	+9
Potash	1.35	1.35	0
Imports:			
Nitrogen	3.35	3.04	-9
Phosphate 2/	.10	.11	+10
Potash	4.56	4.45	-2
Exports:			
Nitrogen	1.58	2.79	+77
Phosphate 2/	3.32	4.85	+46
Potash	.34	.47	+38
Domestic Supply: 3/			
Nitrogen	13.93	13.24	-5
Phosphate 2/	6.20	5.52	-11
Potash	6.03	5.64	-7

1/ Data for July through April for the fertilizer year starting July 1. 2/ Does not include phosphate rock. 3/ Includes requirements for industrial uses.

superphosphate accounted for almost all of the remaining phosphate exports.
Potash exports increased 38 percent to about 472,000 tons, mainly because of increased exports of potassium chloride.

Stable domestic demand, larger U.S. production, and lower fertilizer prices have discouraged nitrogen and potash imports. During July-April, nitrogen imports were 9 percent below last year, while potash imports were down 2 percent.

Production

Domestic nitrogen production increased about 12 percent to 11.3 million tons during July-April. Phosphate production was up 9 percent to 9.5 million tons, while potash production was unchanged at over 1.3 million tons.

Table 19--Average May U.S. farm prices for selected fertilizer materials 1/

Year	Anhydrous ammonia (82%)	Triple super-phosphate (44-46%)	Diammonium phosphate (18-46-0%)	Potash (60%)	Mixed (6-24-(24%)
			Dollars per short ton		
1982	255	228	262	155	219
1983	237	214	249	143	206
1984	280	231	271	147	217
1985	252	203	240	128	192

1/ Based on surveys of farm supply dealers conducted by the Statistical Reporting Service, USDA

The industry is adjusting production because current fertilizer export levels and the summer decline in domestic fertilizer use will not sustain the plant operating rates of last spring. Florida phosphate and Canadian potash producers are shutting down mines temporarily as inventories build.

Prices

Unchanged domestic consumption and plentiful supplies resulted in May 1985 farm fertilizer prices averaging 8.2 percent below last year. May prices of anhydrous ammonia were down 10 percent from a year earlier while ammonium nitrate and urea prices were off about 4.4 percent (table 19). Triple superphosphate, muriate of potash, and diammonium phosphate prices were down about 12 percent.

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Appendix table 1-- Acreage irrigated with on-farm pumped water

Region	Electricity 1974	1977	1980	1983	Diesel 1974	1977	1980	1983	Gasoline 1974	1977	1980	1983
	Thousand Acres											
Northeast	31	30	25	35	68	101	107	147	177	160	133	135
Lake States	295	452	595	705	81	237	424	432	23	49	106	114
Corn Belt	72	155	286	315	75	256	429	460	114	95	59	54
Northern Plains	1,572	2,612	3,274	3,594	1,544	2,915	2,793	2,846	151	72	79	81
Appalachia	104	18	30	23	22	87	139	182	62	114	113	128
Southeast	587	582	963	1,120	1,045	1,613	1,968	2,319	189	240	211	197
Delta States	504	781	1,571	2,019	645	1,102	1,197	1,499	591	310	93	28
Southern Plains	2,007	2,139	2,054	1,957	151	156	165	159	108	105	103	94
Mountain	4,296	4,619	4,789	4,872	308	350	333	380	86	75	138	63
Pacific	6,197	6,717	6,745	7,118	4	9	134	130	0	0	0	0
Alaska	3	2	2	2	*	-	-	-	1	*	*	-
Hawaii	72	85	85	85	-	-	-	-	1	-	-	-
Total	15,743	18,192	20,419	21,845	3,943	6,826	7,689	8,554	1,503	1,220	1,035	894
	Natural gas				LP gas				Total			
Northeast	-	-	41	-	18	13	13	13	294	304	319	330
Lake States	-	-	-	-	11	12	29	18	410	750	1,154	1,269
Corn Belt	1	25	6	5	100	103	146	155	362	634	926	989
Northern Plains	2,430	3,231	3,593	3,638	1,552	1,008	1,291	1,433	7,249	9,838	11,030	11,592
Appalachia	*	2	2	3	3	1	6	7	191	222	290	343
Southeast	*	2	2	2	222	273	336	222	2,043	2,710	3,480	3,860
Delta States	205	182	117	110	744	287	58	104	2,689	2,662	3,036	3,760
Southern Plains	6,742	6,341	6,204	5,837	508	529	493	474	9,516	9,270	9,019	8,521
Mountain	1,156	1,100	1,089	1,075	184	138	198	183	6,030	6,282	6,547	6,573
Pacific	85	31	85	85	-	-	-	-	6,286	6,757	6,964	7,333
Alaska	-	-	-	-	-	-	-	-	4	2	2	2
Hawaii	-	-	-	-	-	-	-	-	73	85	85	85
Total	10,619	10,914	11,139	10,755	3,342	2,364	2,570	2,609	35,147	39,516	42,852	44,657

- = none reported. * Less than 1,000 acres.

Source: (5).

Appendix table 2--Total energy expenditures and annual percentage change for on-farm pumped irrigation water

Region	Expenditures for								
	Electricity			Diesel			Gasoline		
	1983 total dollars	Annual change 74-80	Annual change 80-83	1983 total dollars	Annual change 74-80	Annual change 80-83	1983 total dollars	Annual change 74-80	Annual change 80-83
	Million	Percent		Million	Percent		Million	Percent	
Northeast	0.9	50.0	41.7	6.4	56.3	27.6	5.3	7.3	5.1
Lake States	26.9	106.7	15.1	27.0	292.4	10.8	7.4	166.7	4.0
Corn Belt	6.7	358.3	16.3	14.2	408.3	13.1	3.1	12.5	3.6
Northern Plains	131.5	62.1	15.8	185.4	75.0	1.0	8.6	19.5	4.4
Appalachia	0.4	4.2	-6.7	7.9	733.3	25.2	6.1	100.0	8.2
Southeast	42.1	135.9	14.6	150.1	219.1	17.2	17.4	82.8	-4.8
Delta States	57.8	173.1	31.8	60.7	93.2	18.7	1.3	-6.9	-23.5
Southern Plaines	87.7	21.3	12.6	11.1	44.1	-3.5	9.3	28.8	-4.9
Mountains	364.8	29.4	5.0	45.3	37.6	-0.2	9.8	4.8	5.1
Pacific	320.4	37.5	6.1	15.2	283.3	-3.7	-	-	-
Alaska and Hawaii	52.0	29.9		-	-	-	-	-	-
Total	1,151.2	36.9	8.1	523.3	93.1	7.1	68.3	20.7	-1.1
	Natural gas			LP gas			Total		
Northeast	-	-	-	0.4	5.6	-	13.0	20.2	12.3
Lake States	-	-	-	1.1	200.0	-5.1	62.4	164.7	11.1
Corn Belt	*	*	*	3.4	25.9	15.9	27.4	89.8	12.8
Northern Plains	150.3	68.8	17.6	102.6	20.0	13.5	578.4	52.8	9.7
Appalachia	*	*	*	0.4	*	33.3	14.8	123.6	15.5
Southeast	*	*	*	18.1	76.5	-5.7	222.7	145.6	11.2
Delta States	2.9	60.0	8.7	4.8	-12.8	55.6	127.5	36.2	21.9
Southern Plains	229.4	39.0	10.3	47.8	23.6	12.5	385.3	31.8	9.9
Mountains	157.6	40.5	29.2	17.1	28.7	-0.6	594.6	30.8	8.6
Pacific	9.7	154.8	11.6	-	-	-	405.3	41.1	5.7
Alaska and Hawaii	-	-	-	-	-	-	52.0	29.0	-
Total	549.9	46.3	16.5	195.7	21.4	9.3	2,488.4	42.5	9.2

- = none reported. * Less than 1,000 acres.

Source: (5).

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Returns To Corn Pest Management Practices. Michael Hanthorn/Michael Duffy, Natural Resource Economics Division, Economic Research Service, U.S. Department of Agriculture. Agricultural Economic Report No. 501.

Abstract: Productivity of pesticides applied to nonirrigated corn is estimated and the nonchemical pest management practices used by corn farmers in the 10 major producing States during 1980 are discussed. The return to $1 spent on herbicides and insecticides was $1.05 and $1.03, respectively. Corn farmers generally applied herbicides and insecticides at optimal levels in 1980. Yields did not vary among tillage systems, but were significantly lower for farmers who mechanically cultivated their fields more than once after planting compared to farmers who cultivated less. Pesticide use and cost varied significantly among these cultural practices.

Returns to Corn And Soybean Tillage Practices. Michael Duffy/Michael Hanthorn, Natural Resource Economics Division, Economic Research Service, U.S. Department of Agriculture. Agricultural Economic Report No. 508.

Abstract: Average per-acre returns differ little for most U.S. corn and soybean farmers using various alternative tillage strategies, according to this analysis of 1980 farm-level production data. Midwest conventional-till soybean farmers, however, accrue a significantly higher average return than do Midwest no-till farmers. Most conservation-till soybean farmers in the three major producing regions incur significantly lower input costs than do conventional-till soybean farmers, but also harvest lower yields except in the Southeast. Significant differences were found in the use of specific corn and soybean inputs among alternative tillage strategies.

Control Of Exotic Pests: Forecasting Economic Impacts. Fred Kuchler and Michael Duffy, Natural Resource Economics Division, Economic Research Service, U.S. Department of Agriculture. Agricultural Economic Report No. 518

Abstract: Dollar losses beyond the farm gate resulting from the entry and establishment of an exotic crop pest may far exceed the direct losses farmers incur. This case study uses an econometric-simulation model to estimate the benefits to U.S. agriculture of preventing entry or establishment of the exotic soybean pest, Phakopsora pachyrhizi Sydow. Seven scenarios with different disease losses in different soybean-producing regions are simulated. Productivity losses caused by the disease generally elevate growers' income levels because commodity price increases outweigh production losses for most growers.

Pesticide Use On Selected Crops: Aggregated Data, 1977-80. Walter L. Ferguson, Natural Resource Economics Division, Economic Research Service, U.S. Department of Agriculture. Agricultural Information Bulletin No. 494.

Abstract: U.S. farms applied an average 556 million pounds of pesticides in 354 million acre-treatments on 175 million acres of field, fruit, and vegetable crops annually from 1977 to 1980. These figures are based on reported pesticide use in surveys completed in various years and do not include all of the above crops in any year surveyed. Because planted acreage showed minimal annual change, general pesticide use per planted acre probably did not vary much from year to year. However, this may not be true for specific pesticides. Herbicides constituted 68 percent of the acre-treatments, insecticides 26 percent, fungicides 4 percent, and all other pesticides 2 percent. Field crops accounted for 89 percent of the acre-treatments, fruits 6 percent, and vegetables 5 percent. Although field corn and soybean farmers accounted for 68 percent of the acre-treatments, the intensity of application was lower for these crops than for other surveyed crops.

Field Crop Pests: Farmers Report The Severity And Intensity. Luis F. Suguiyama and Gerald A. Carlson, Natural Resource Economics Division, Economic Research Service, U.S. Department of Agriculture. Agricultural Information Bulletin No. 487

Abstract: The extent of pesticide use and the prevalence of pest populations on field crops vary according to the type of pest, crop, region, and survey year. This report estimates the importance of individual pests on selected field crops on a regional and national basis. Surveyed farmers report that the most severe and intense pests were weeds in corn and soybean production, weeds and insects in cotton, and diseases and insects in tobacco. This study relied upon farmers' ability to identify the pest infestations causing economic damage on on nine selected field crops. Detailed estimates of the relative importance, severity, and time intensity of target pests are tabulated.

Fruit Crop Pests: Growers Report The Severity And Intensity. Luis F. Suguiyama and Gerald A. Carlson, Natural Resource Economics Division, Economic Research Service, U.S. Department of Agriculture. Agricultural Information Bulletin No. 488.

Abstract: Growers reported that successful fruit production required extensive pesticide use in 1977 and 1978. Deciduous fruit crops required more pesticides than did citrus fruits; and insects and diseases were the most severe fruit pests. The extent of pesticide use varied because the severity and intensity of the pests targeted for study differed according to the pest, species, region, survey year, and type and density of fruit production. This report, which relied upon growers' ability to identify the pests damaging the selected fruit crops, presents regional estimates of the most frequently reported pests requiring pesticide control on both citrus and deciduous fruit crops.

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